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Hurricane Bob Preparedness Assessment for Coastal Areas of Southern New England and New York



**US Army Corps
of Engineers**



**FEDERAL EMERGENCY
MANAGEMENT AGENCY**

Hurricane Bob Preparedness Assessment for Coastal Areas of Southern New England and New York

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PART I: SOUTHERN NEW ENGLAND

I - INTRODUCTION

Background

On August 17 through August 19, 1991, the east coast of the United States experienced its only hurricane of the 1991 hurricane season, Hurricane Bob. Hurricane Bob was responsible for the issuance of hurricane watches and hurricane warnings from North Carolina to Maine prior to its initial landfall at Newport, Rhode Island on the afternoon of August 19. Although loss of life and storm damages extended as far south as South Carolina and as far north as Nova Scotia, Canada, New England suffered the brunt of the impact. As reported by the National Weather Service (NWS) in the Disaster Survey Report for Hurricane Bob, eleven of the 17 total deaths attributed to Hurricane Bob were New England residents, five of which resulted from flood related accidents. Property damages and cleanup costs were estimated at \$1.5 billion.

At the request of States, the Federal Emergency Management Agency (FEMA) and the Corps of Engineers cooperatively sponsor and conduct comprehensive hurricane evacuation studies aimed at reducing loss of life caused by hurricane induced coastal flooding. Several regional studies have been completed for areas along the southeastern Atlantic and Gulf Atlantic shorelines and completion of ongoing studies for Connecticut, Rhode Island, and southern Massachusetts are forthcoming. Hurricane evacuations conducted prior to recent hurricane events, such as those evacuations executed prior to Hurricane Hugo in 1989, have shown that products developed by these studies are reliable and extremely useful during large scale public evacuations.

The hurricane evacuation study products for the study areas along the south Atlantic and Gulf coasts were developed to meet the needs of State and county emergency management officials. The absence of active county governments in New England necessitates hurricane preparedness products designed to support the functions of State and community officials, with special emphasis on implementation at the community level. Hurricane Bob's impacts on the northeastern United States present an opportunity to collect actual information on preparedness and response actions of New England State and local officials and to gain further insight into current preparedness procedures. This information can be used during the final development and future implementation of study products of New England hurricane evacuation studies to ensure that the products complement existing hurricane response plans, conform to in-place communication systems, and consider the evacuation decision process used by New England officials.

Authority

This study is a cooperative effort between FEMA, the Corps of Engineers, and the NWS. Funding was provided by FEMA under the Disaster Relief Act of 1974; and by the Army Corps of Engineers under the Flood Plain Management Services Program, Section 206, of the Flood Control Act of 1960.

Study Purpose

This assessment serves two purposes. First, it documents hurricane preparedness procedures and communication systems presently being used by NWS officials, and State and local emergency management officials in southern New England for hurricane preparedness. Secondly, it presents collected information regarding decisions made and actions taken by these officials in preparing the region for Hurricane Bob. Additionally, a separate report entitled Hurricane Bob, August 1991, High Water Marks Eastern Rhode Island & Southern Massachusetts was completed to historically document the elevations and locations of 99 high water marks recorded along eastern Rhode Island and southern Massachusetts after Hurricane Bob.

Study objectives consider many aspects of current hurricane preparedness methods employed by State and local officials. Results will be used to best tailor final hurricane evacuation study products such that these products will complement current State and local procedures and attempt to meet the needs of New England's officials. Specific study objectives are as follows:

1. Compare surge elevations recorded by tide gages positioned in Narragansett Bay and Buzzard's Bay to forecasted surge estimates computed by the National Hurricane Center's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model.
2. Identify the roles and standard procedures of the NWS, State Emergency Management Offices, and local communities, and their interrelationship, when warning and making recommendations to the public.
3. Document hurricane preparedness decisions and actions made prior to Hurricane Bob's landfall by State and local officials, and present the bases which officials cited for arriving at their decisions and actions.
4. Identify the various communication systems used by NWS officials, and State and local emergency management officials for disseminating hurricane forecasts and advisories to the public.

5. Evaluate the extent to which the FEMA/Corps of Engineers' interim hurricane evacuation preparedness products were used by officials in preparation for Hurricane Bob, and report comments made by officials regarding the effectiveness and usefulness of these products.

Study Area Description

It was mutually agreed upon by State officials from the Connecticut, Rhode Island, and Massachusetts Offices of Emergency Management, and personnel from the American Red Cross, FEMA Region I, and the New England Division Corps of Engineers that the New England portion of this assessment should focus on local areas of New England which were most severely impacted by Hurricane Bob. In light of this, the study area comprises the coastal municipalities from as far west as New Haven, Connecticut, extending east through Rhode Island to portions of mid-Cape Cod, Massachusetts. Input received from officials of these municipalities, local officials from Martha's Vineyard and Nantucket, and NWS and State emergency management officials serving these areas provides the basis for the discussions presented in this report.

Study Methodology

Six months after Hurricane Bob's occurrence, the New England Division contracted Hayden-Wegman Consulting Engineers to conduct personal and mail interviews of NWS, State emergency management officials, and local officials in the study area. Standard questionnaires were jointly developed by the New England Division and Hayden-Wegman, and samples of each questionnaire type are provided in Appendix A. Hayden-Wegman completed a total of four mail interviews of NWS officials, six personal interviews of State emergency management officials, and 63 personal interviews of local officials. The local officials who were interviewed were either emergency management directors or representatives from the emergency management departments of their communities. A list of names and the community or region that each interviewed official represented is provided in Appendix B.

The New England Division further coordinated with the NWS and the State Offices of Emergency Management to obtain additional information regarding their hurricane warning and forecast dissemination responsibilities. This information, and summaries of tabulated questionnaire responses, are the basis for which stated objectives were addressed in this report.

II - SYNOPTIC HISTORY AND STORM SURGE

Meteorological Overview

At 2:00 p.m. on August 17, 1991, tropical cyclone Bob strengthened from a tropical storm to a hurricane while centered approximately 235 miles east of Daytona Beach, Florida. The tropical depression originated from disturbed weather of a frontal trough, and was the third tropical depression of the season. Soon after its formation, Hurricane Bob continued to strengthen over the warm subtropical water. It turned north-northeast, while increasing its forward speed, and began following a track which paralleled the east coast of the United States.

Hurricane Bob moved within 30 miles of Cape Hatteras, North Carolina near midnight on August 18, where it continued its north-northeast track while further increasing its forward speed and intensity. At 2:00 a.m. on August 19, Hurricane Bob passed approximately 100 miles off the shore of Norfolk, Virginia where it had reached its maximum intensity of Category 3 (see Table 1 - Saffir/Simpson Hurricane Scale with Central Barometric Pressure Ranges). As it continued its course aimed directly at New England, an upper atmospheric low pressure area helped Hurricane Bob maintain its intensity even as the cooler waters and air of the mid-Atlantic began to weaken the system.

At 2:00 p.m. on August 19, Hurricane Bob made its initial landfall at Newport, Rhode Island with a forward speed of 32 miles per hour and maximum sustained winds of a Category 2 hurricane. Its intensity further weakened as it moved over the States of Rhode Island and Massachusetts. Its track passed a few miles south of Boston, Massachusetts before reemerging over Massachusetts Bay and making final landfall as a tropical storm near Rockland, Maine. Figure 1, referenced from the National Hurricane Center's Preliminary Report, Hurricane Bob, 16-20 August 1991, illustrates Hurricane Bob's track, and its meteorological classification from development through dissipation.

Unofficial reports indicate that wind gusts as far east as mid-Cape Cod in Brewster, Massachusetts reached 120 to 125 miles per hour. Expansion of the hurricane's eye as it progressed towards New England led to an extremely large radius of maximum winds about its eye at time of landfall. As a result, surges in Buzzard's Bay were considerably lower than what could have been experienced. Hurricane Bob's arrival in New England, well before normal high tides, further contributed to less severe hurricane storm tides.

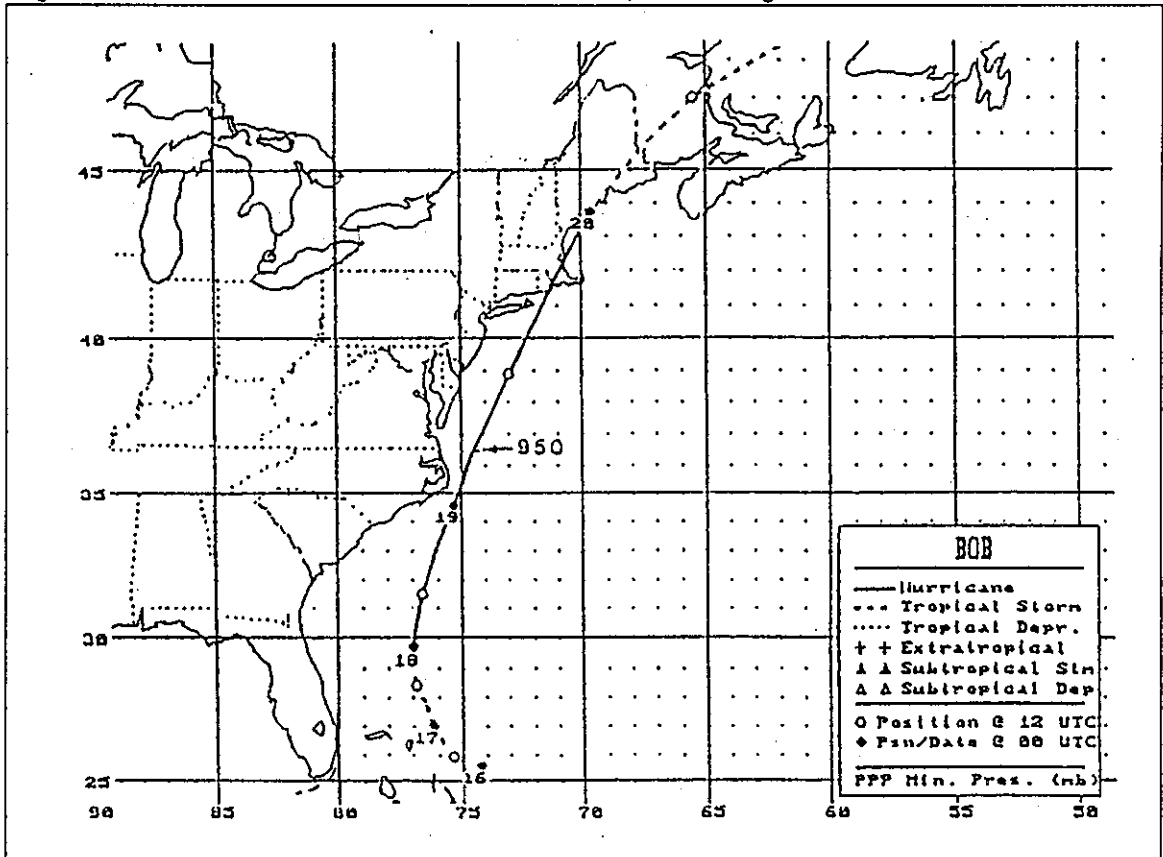
Forecast Probabilities and Storm Characteristics

Three days prior to Hurricane Bob's landfall in New England, hurricane specialists at the National Hurricane Center (NHC) estimated that the developing cyclone had a one in 14 chance of passing within 65 miles of major New England cities. As its

Table 1 – Saffir/Simpson Hurricane Scale with Central Barometric Pressure Ranges

| Intensity Category | Central Pressure | | Wind Speed | | Damage Potential |
|--------------------|------------------|-------------|------------|---------|------------------|
| | Millibars | Inches | MPH | Knots | |
| One | >980 | >28.94 | 74–95 | 64–83 | Minimal |
| Two | 965–979 | 28.50–28.91 | 96–110 | 84–96 | Moderate |
| Three | 945–964 | 27.91–28.47 | 111–130 | 97–113 | Extensive |
| Four | 920–944 | 27.17–27.88 | 131–155 | 114–135 | Extreme |
| Five | <920 | <27.17 | >155 | >135 | Catastrophic |

Figure 1 – Best Track Positions for Hurricane Bob, 16–20 August 1991



intensity increased and it continued to follow a distinct north-northeast track, probabilities that Hurricane Bob might strike New England continued to climb. At 12:00 p.m. on August 18, a hurricane watch was issued for portions of southern New England. Six hours later, a hurricane warning was issued for those same regions. Probabilities that the eye would reach New England cities had risen to one in three. The eye moved 120 miles due east of Wilmington, North Carolina and its central pressure dropped to 960 millibars. Wind speed increased to 106 miles per hour, while Hurricane Bob continued accelerating directly towards New England.

Table 2 lists the probabilities of Hurricane Bob passing within 65 miles of benchmark cities in New York and New England. These probabilities are updated with each regularly scheduled Public Advisory and Marine Advisory issued by the NHC, and they are valid for prescribed time intervals denoted by each advisory. Table 3 provides instantaneous eye locations and associated meteorological characteristics which correspond to times listed. These tables can be used to illustrate changes in landfall probabilities as Hurricane Bob migrated along its track. Eye locations and meteorological characteristics were linearly interpolated from preliminary best track data determined by the NHC. Information shown in these tables was made available to public and private interests through a series of Public and Marine Advisories issued by the NHC throughout Hurricane Bob's existence.

Indicative of the data presented in Tables 2 and 3, on the morning of August 19, it was highly probable that Hurricane Bob's track would graze the eastern tip of Long Island and make landfall in southern New England. When Hurricane Bob eventually made landfall at Newport, Rhode Island on August 19, it came as no surprise to those officials that had monitored the NHC's advisories. The Public and Marine Advisories issued at 6:00 a.m. on August 19 indicated that Montauk Point on Long Island and Providence, Rhode Island had a 73 and a 69 percent chance, respectively, of Hurricane Bob's track passing within 65 miles of their locations.

Comparison of Forecasted Storm Surge and Observed Storm Surge

One study product of the FEMA/Corps of Engineers hurricane evacuation studies is inundation mapping which delineates hurricane induced coastal flood limits within study areas. Flood area delineations shown on the inundation mapping represent potential worst case flooding caused by hypothetical hurricanes. Meteorological parameters of New England's past hurricanes were used to define those hypothetical hurricanes which have a likelihood of occurring in New England. The NHC calculated estimates of the surge resulting from hypothetical hurricanes using the SLOSH model.

The SLOSH model was developed by the NWS and has been used by the NHC in support of all recent hurricane evacuation study efforts preformed by FEMA and the Corps of Engineers. The model uses a computerized mathematical technique and extensive bathymetric and topographic data for analyzing the potential surge

Table 2 - Forecasted Percent Probabilities for Locations of New England and New York

| Advisory Issue Time | Probability End Time | Montauk Pt. NY | New York NY | Providence RI | Boston MA | Hyannis MA | Nantucket MA |
|------------------------|-------------------------|-------------------|----------------|------------------|--------------|---------------|-----------------|
| August 16 10:30 PM | August 19 8:00 PM | 8 | 8 | 7 | 6 | 7 | 7 |
| August 18 12:00 PM | August 21 8:00 AM | 21 | 19 | 20 | 18 | 20 | 20 |
| August 18 6:00 PM | August 21 2:00 PM | 35 | 26 | 33 | 30 | 34 | 35 |
| August 18 10:30 PM | August 21 8:00 PM | 40 | 27 | 37 | 33 | 39 | 40 |
| August 19 6:00 AM | August 22 2:00 AM | 73 | 40 | 69 | 64 | 59 | 49 |
| August 19 12:00 PM | August 22 8:00 AM | 99 | 23 | 85 | 75 | 70 | 55 |

Table 3 - Meteorological Characteristics of Hurricane Bob

| Time & Date | Eye Position | | | Central Pressure (millibars) | Wind Speed (mph) | Saffir/ Simpson Category |
|-----------------------|----------------------|-----------------------|---|------------------------------------|------------------------|--------------------------------|
| | Latitude (deg. N) | Longitude (deg. W) | Location | | | |
| August 16 10:30 PM | 27.4 | 76.3 | 250 miles east of Vero Beach, FL | 1001 | 48 | Tropical Storm |
| August 18 12:00 PM | 32.5 | 76.3 | 220 miles east of Charlestown, SC | 968 | 95 | 2 |
| August 18 6:00 PM | 34.1 | 75.6 | 120 miles due east of Wilmington, NC | 960 | 106 | 3 |
| August 18 10:30 PM | 35.4 | 75.0 | 25 miles east of Cape Hatteras, NC. | 954 | 112 | 3 |
| August 19 6:00 AM | 38.1 | 73.5 | 90 miles south east of Cape May, NJ | 952 | 112 | 3 |
| August 19 12:00 PM | 40.6 | 71.9 | Less than 30 miles from Eastern Long Island, NY | 960 | 101 | 3 |

generated by a hurricane of prescribed meteorological parameters. Analyses of several hypothetical hurricanes enables the hurricane scenario which causes the most severe flooding to be determined.

Actual hurricane events provide the developers of the SLOSH model, and researchers, opportunities to compare observed surge heights to the theoretical surge heights estimated using the SLOSH model. Researchers from the NHC evaluated the SLOSH model's performance for Hurricane Bob. For areas of New England and New York, Figure 2 graphically compares SLOSH model surge height estimates to the observed surge levels recorded at tide gages located in these areas.

In Figure 2, Hurricane Bob's track is represented by the solid straight line extending in a north-northeast direction over the State of Rhode Island. The smooth curved lines shown staggered over the ocean waters delineate one foot contours of the SLOSH model's surge estimates. SLOSH surge height estimates are shown for several sites along the coast to include those sites where tide gages are located. Circled values denote the maximum observed surge height recorded at tide gages. Values which are not circled are the SLOSH model's surge height estimates. All surge heights are given in feet referenced to the National Geodetic Vertical Datum (NGVD).

As expected, and illustrated by the surge contours in Figure 2, SLOSH surge estimates rapidly increase to the "right of the eye" as ocean water funnels northward into Buzzard's Bay. In Bourne, Massachusetts, near the south entrance of the Cape Cod Canal, the surge predicted by the SLOSH model exactly matched the 9.1 foot surge that was observed. Likewise, the SLOSH model performed equally well at the Fox Point Hurricane Barrier in Providence, Rhode Island. At this location, the SLOSH model's maximum surge estimate and the observed maximum surge were 6.6 feet (NGVD).

The graphs in Figure 3 illustrate comparisons made between the observed storm surge time histories of tide gages positioned at Newport, Rhode Island and Woods Hole, Massachusetts to SLOSH computed storm surge time histories at these same locations. As shown by the graphs, forecasted surge, when compared to observed surge tends to overestimate heights at times before maximum surge occurs. At times after maximum surge heights occur, the SLOSH model tends to underestimate observed heights. The forecasted and observed times at which maximum surge occurred were the same at Newport, Rhode Island. At Woods Hole, the forecasted maximum surge height was calculated to be the same as the actual height, but the forecasted maximum surge was predicted to occur approximately 30 minutes sooner than it actually did.

Overall the SLOSH model performed well. At all tide gage locations shown in Figure 2, maximum surge estimates were within a few tenths of a foot of observed levels, and the times at which maximum heights were predicted to occur were within an hour of their actual occurrence.

Figure 2 - SLOSH Model Surge Height Comparison

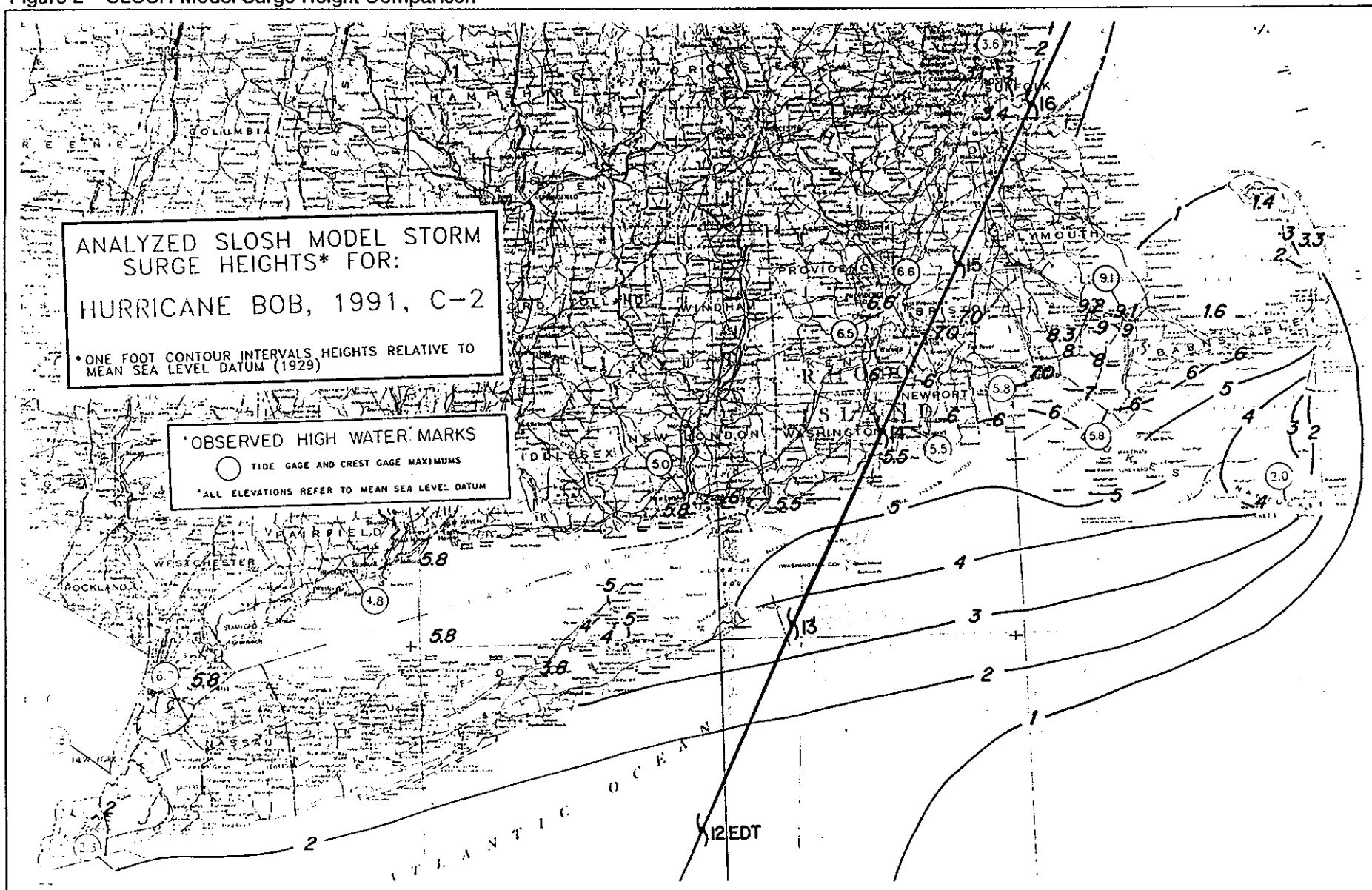
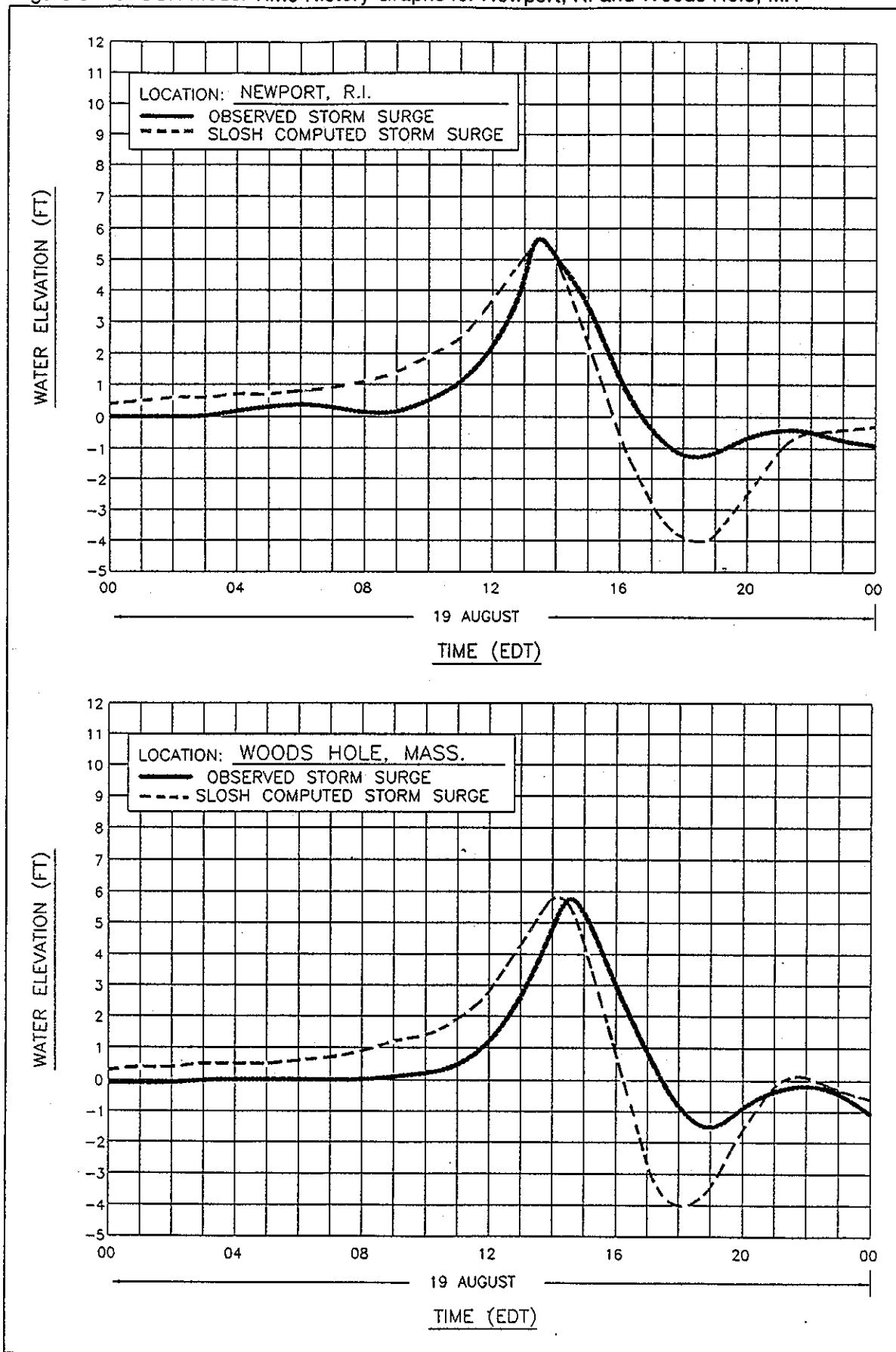


Figure 3 - SLOSH Model Time History Graphs for Newport, RI and Woods Hole, MA



III - NATIONAL WEATHER SERVICE

Hurricane Warning Program

The NWS under the National Oceanic and Atmospheric Administration (NOAA) has the primary mission of providing weather and flood warning for all of the United States and its surrounding waters. Prevention of loss of life and reduction of property damages related to hurricane hazards are dependent upon the NWS executing its Hurricane Warning Program. This multi-tiered program focuses on cooperation by a network of NWS's local and regional offices, and its specialized technical centers to timely and effectively coordinate dissemination of accurate hurricane forecasts and advisories to the public and private sectors.

The following paragraphs outline responsibilities that NWS offices involved in New England's hurricane preparedness currently have with relation to preparing and disseminating weather products as part of its hurricane warning program. It is proposed by NOAA that in the near future the NWS will undergo several major structure changes and advancements. The information in this section considers the NWS structure and weather products as they exist today, as it is beyond the scope of this assessment to discuss the affects of the proposed changes. More information on this subject can be found in the Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service (MAR), March 1989.

National Hurricane Center

The NHC located in Coral Gables, Florida has the overall responsibility for preparing and distributing warnings and forecasts for tropical and subtropical cyclones in the Atlantic, Caribbean, Gulf of Mexico, and the eastern Pacific Ocean. Research Meteorologist and Hurricane Specialists at the NHC use satellite imagery, air reconnaissance flight information, and meteorological data to analyze current weather conditions, and predict weather changes that may adversely impact the marine and coastal areas. The NHC is responsible for assessing which coastal locations are likely to be threatened by hurricanes, and for issuing hurricane watches and hurricane warnings as appropriate.

Two basic weather forecast products prepared by the NHC, which support other NWS offices and public users, are the Tropical Cyclone Marine Advisories (Marine Advisories) and the Tropical Cyclone Public Advisories (Public Advisories). Marine Advisories are designed to provide the coastal and marine communities with concise descriptive cyclone information and forecasts. This includes: watch and warning area limits; the cyclone's current meteorological characteristics and position; 12-, 24-, 36-, 48-, and 72-hour extended forecasts on the hurricane's eye position, its associated wind profile, as well as many other forecasted meteorological characteristics.

Public Advisories are tools specifically designed for warning the public of hurricanes. Similar to the Marine Advisory, the Public Advisory offers descriptions of the watch and warning areas, some extended forecasts, and current meteorological and position information. However, Public Advisories are less technically detailed than Marine Advisories and they are written in paragraph format. The NHC uses this format so that public officials, or media personnel, can restate Public Advisories verbatim with the expectation that a logical, easily understood advisory will be heard by all listeners. NWS officials fear that people re-transmitting Marine Advisories may incorrectly interpret information, or that information may be misconstrued, therefore Public Advisories were developed. The probabilities that benchmark cities will experience hurricane conditions are appended to regularly scheduled Public and Marine Advisories.

Marine and Public Advisories are issued at least every six hours after a cyclone has formed. The frequency at which subsequent Public Advisories are issued varies with the threat posed by the cyclone. Public Advisories are issued at three hour time intervals after a hurricane watch has been issued, and the time interval is further reduced to two hours after a hurricane warning has been issued. The NHC may issue unscheduled Marine and Public Advisories between scheduled issuance times if significant changes in weather or forecasts are realized. Samples of Marine and Public Advisories issued during Hurricane Bob are shown in Appendix C.

Regional and Local Weather Service Offices

Presently, the responsibility for disseminating NHC watches, warnings, and advisories, and for making daily weather forecasts has been divided among several regional and local NWS offices. Regional offices, called Weather Service Forecast Offices (WSFO), prepare forecasts for their regions and provide weather data monitoring support and forecast guidance to their subordinate local Weather Service Offices (WSO). Each WSFO and WSO are assigned areas of responsibility, or County Warning Areas, for which they are required to conduct weather forecasting and weather warning functions.

In situations where County Warning Areas may be impacted by a hurricane, each Meteorologist In Charge (MIC) at these offices uses in-house monitoring and forecasting capabilities, along with NHC products to inform the public of hurricane updates and anticipated local hazards. They also serve to amplify warnings and advisories originating from the NHC. The region's WSFO is responsible for ensuring consistency among all forecasts and warnings issued by its WSOs and for coordinating with adjacent WSFOs for developing consistent forecasts along WSFO jurisdictional boundaries.

Presently, weather forecast and warning for the southern New England region is headed by the WSFO located at Logan Airport, Boston, Massachusetts. Five WSOs supporting the Boston WSFO are located at Chatham and Worcester,

Massachusetts; Providence, Rhode Island; Bridgeport and Hartford, Connecticut. Once restructuring of the NWS takes place, a single Weather Forecast Office (WFO) to be located in Taunton, Massachusetts will assume forecast and warning responsibilities for most of southern New England.

Hurricane Local Statements (HLS) are the primary product produced by WSFOs and WSOs for warning the public of hurricane hazards. These products are normally released following each regularly scheduled Marine and Public Advisory. This product was developed to provide the public with a steady flow of information pertinent to their local area. Information contained in Hurricane Local Statements expands upon the anticipated local hurricane impacts such as expected storm surge, wind speeds, rainfall, and the time of heightened conditions for a particular County Warning Area. Efforts are taken to further disseminate information reported in the NHC's Marine and Public Advisories, but to include only information which directly applies to their County Warning Area. A sample Hurricane Local Statement issued during Hurricane Bob is shown in Appendix C.

During periods of significant weather, WSFOs and WSOs will usually issue Special Weather Statements and/or Short Term Weather Summaries and Forecasts. Presently, the information that is contained in these products is incorporated into Hurricane Local Statements during a tropical cyclone threat. Each WSFO also issues a State Forecast Discussion product at least four times a day. This product is intended primarily for other NWS and private forecasters and contains a technical description of expected and possibly alternative weather scenarios, basis for warning decisions, interpretation of numerical guidance products, and sometimes a list of internal NWS actions needed (e.g. enhanced staffing recommendations for WSOs, emergency generator checkout, etc.). More information regarding the products described above can be found in Part C, Chapter 41, of the NWS Operations Manual.

Dissemination of National Weather Service Products

The NWS relies upon the Automation of Field Operations and Services system for internal dissemination of products. From this system, the NHC, WSFO, and WSO products are disseminated to external users via the NOAA Weather Wire Service (NWWS) and the Family of Services (FOS).

The NWWS is a satellite-based system managed by GTE Federal Systems Division. Subscribers to this service receive NWS products over compact satellite receivers and microcomputer terminals. The service is available to both public and private entities. Users can select and receive any number of hundreds of NWS products, which can include Public and Marine Advisories as well as Hurricane Local Statements. Depending upon the specific user's equipment, these products can be converted to hardcopy teletype form or stored as computer files. The NWS has provided one designated agency per State with a NWWS terminal without charge.

Many states have linked their NWS terminal with statewide communication systems, such as their State Police law enforcement systems. This junction allows selected NWS products to be fanned out automatically (without time-consuming and error-prone manual editing) to a wide cross section of local jurisdictions and other State agencies. State emergency management officials further relay NWS products to local officials over dedicated phone systems, commercial telephones, Fax machines, and State radio systems.

The Family of Services makes NWS products available to private vendors, who redistribute weather information to clients throughout the Nation. The media often-times receives NWS information through private distribution services that subscribe to the Family of Services. Wide dissemination to the public is provided by the Weather Channel, which relays area-specific and unedited NWS warnings, forecasts, and statements to cable subscribers.

The National Warning System (NAWAS) is a dedicated phone warning system which links at least one agency of every State to the National Warning Point located in Washington, DC. This system serves to give State officials advance warning of national scale threats such as possible enemy attacks, nuclear emission leaks, or severe regional weather emergencies. States operate similar dedicated phone systems commonly referred to as State NAWAS which warn counties or municipalities from threats monitored at the State level. Both NAWAS and State NAWAS are linked by dispatchers at each State's Warning Point. Warnings issued at the national level for a particular State can in turn be re-dispatched and heard by key officials of the State, or by local officials from counties and municipalities located within the State.

At least one NWS office per State has access to NAWAS. This system is used directly by the NWS to verbally alert threatened States of impending severe weather. The NWS also monitors State NAWAS phone circuits for key reports that may be relayed by emergency management officials who have access to the system.

The NOAA Weather Radio (NWR) is a service offered by the NWS that provides continuous broadcast of timely weather information affecting or expected to affect the broadcast area. WSFO and WSO personnel operate the NWR stations of their County Warning Areas. NWR message format consists of several prerecorded messages of short duration (usually up to about 100 seconds per message) broadcast repeatedly and updated as weather forecasts change. Overland and offshore observations, warnings, and forecasts are all broadcasted at coastal NWR sites. As a hurricane approaches the NWR listening area, announcements of recommended hurricane preparedness actions are included as part of the NWR broadcasts. Essential information from the NHC's Public and Marine Advisories as well as appropriate WSFO/WSO Hurricane Local Statements are broadcasted over the NWR. For a nominal cost, individuals can purchase a weather radio and receive weather information in real time directly from the NWS.

NWS officials will initiate a select number of telephone calls to State and Federal officials when tropical storm or hurricane watches and warnings are issued. Also, the WSFO and WSO MICs will often confer with key emergency management contacts to provide early notification of a potential weather development or provide more in-depth information during severe weather events. Under normal staffing, the NWS has limited capabilities of providing information by telephone. However, during a major event such as a hurricane, the NWS will usually augment their staff to assist with telephone calls from State and local emergency managers and the media. Although the NWS is not equipped to disseminate weather information by Fax, an administrative Fax machine can be used as a backup system if all other means fail.

IV - NEW ENGLAND'S HURRICANE PREPAREDNESS

State Responsibilities

State emergency management officials assume a critical role in the hurricane preparedness process by taking the lead as the primary coordinators between the NWS, their Governor's office, other State agencies, other service organizations, local communities, the media, and the public. Each State emergency management agency serves as a central office for incoming reports, warnings, advisories, as well as requests for emergency assistance and requests for current updates on hurricane threats, and are looked upon by communities for guidance on appropriate preparedness measures that should be taken.

In terms of retrieving NWS weather information, State officials are responsible for monitoring Hurricane Local Statements and other weather forecasts and warnings broadcasted by NWS local offices and the NHC for regions of their State. The Massachusetts Emergency Management Agency (MEMA), Rhode Island Emergency Management Agency (RIEMA), and the Connecticut Office of Emergency Management (CTOEM) each subscribe to the NWS and receive hardcopy NWS products. State officials are responsible for notifying community officials of impending hurricane threats and further disseminating NWS products in support of local officials.

In addition to their role in relaying weather products to local officials, State officials typically give public evacuation guidance to communities or make general evacuation recommendations to people in flood-prone areas. States have the authority to order public evacuations, but Connecticut, Rhode Island, and Massachusetts have taken the position that evacuation orders are most appropriately made at the community level. State emergency management officials coordinate resources needed in support of community actions resulting from State recommendations, and maintain coordination with communities to assess the State's overall preparedness status.

During periods of significant weather, the Governor's office looks to its State emergency management agency for periodic assessments of the State's current threat, current preparedness situation, and for any recommendations by the agency's director. As stated previously, State officials rely on NWS products and incoming reports by local officials to present a clear picture of the State's readiness in response to an anticipated storm. Directors can only make well informed preparedness assessments and appropriate recommendations to the Governor after compiling all of the local status reports and analyzing NWS forecasts. The Governor may declare a State of Emergency in order to assume command of all State resources so that they can be used to support local preparedness and that they are on-line for timely assistance to local recovery operations. In the event a State of Emergency is declared, the Governor's office further relies on its emergency management agency for coordinating

between State agencies and communities for distribution of resources. It is important to recognize that the hurricane preparedness actions initiated at the local level, followed by upward reporting of these actions to the State emergency management agency, significantly influence the recommendations that are ultimately made to the Governor's office.

Community Responsibilities

In New England, local community officials have the responsibility for local hurricane preparedness and local hurricane response. Specific functions within their preparedness plans include: designating suitable public shelters in concert with the American Red Cross; implementing community hurricane response plans; maintaining communication and warning systems; and coordinating with State and NWS officials. Response functions include: making evacuation decisions and recommending or ordering evacuations; notifying businesses to temporarily close; assisting during evacuations of hospitals or other facilities requiring support; working with American Red Cross personnel to provide public refuge to evacuees; reporting to State emergency management officials; and making requests for State resources as needed.

The highest ranking local official in New England communities has evacuation decision authority. The positions that these officials hold vary widely depending upon the size of a community, its chartered government, and the State in which it is located. Some communities have publicly elected mayors, selectmen, or chief executive officers, while others are headed by a town council and their elected town council president. Regardless of their form of government, each city or town has an official appointed to coordinate emergency management duties on a full-time, part-time, or volunteer basis. The community decision makers are kept aware of potential hurricane threats by the emergency manager, and other community officials.

Once the threat becomes apparent, communities generally hold coordination meetings of key community officials. The purpose of a community coordination meeting is to inform all officials of the impending hurricane, to identify potential impacts, and to collectively determine the community's best preparedness plan which will minimize the hurricane's impacts. After thorough analyses of State recommendations, NWS forecasts, and an assessment of their own vulnerability, the highest ranking official, after consulting with other community officials, decides what measures shall be taken. In many communities, evacuation decision responsibilities are delegated by the highest ranking official to a single official such as the police chief, fire chief, or the emergency manager. In these communities, the preparedness actions ultimately taken by the community are based upon the knowledge and experience of one or a few officials.

At the community level, whether evacuation decisions are made by the highest ranking official, or by a delegated official, final evacuation decisions, in many instances, are made within a few hours prior to forecasted landfall. Consequently, many public evacuations are conducted during periods of deteriorating weather with an increased risk of evacuation efforts being impeded by pre-hurricane landfall hazards. Furthermore, because local officials are responsible only for the residents within their communities' boundaries and each community makes its own evacuation decision, communities within a single county or an entire State may respond very differently to the same hurricane threat. Recommendations made by State emergency management officials, and State Emergency Declarations, provide the only consistency for evacuations extending across several contiguous communities.

Connecticut's Dissemination Systems and Procedures

The CTOEM operates from the State Emergency Operations Center (EOC) in Hartford, and is supported by five area offices strategically located throughout the State. Area emergency management offices located in Newtown, Colchester, and Meriden serve southern Connecticut, including its 25 coastal communities. Officials at these offices function as liaisons between communities and the State EOC. Area coordinators keep officials at the State EOC informed of community preparedness status prior to a hurricane and community recovery status after a hurricane has passed. They are further responsible for amplifying warnings, watches, storm forecasts, or any recommendations originating from officials at the State EOC.

The State EOC receives Public Advisories from the NHC and Hurricane Local Statements from the the Hartford and Bridgeport WSOs over NWWS.

The State does not subscribe to the NHC's Marine Advisories. As referenced by the State Warning Plan, initial hurricane watches and warnings received over NWWS are re-issued over the State Warning Systems, however, no standard procedures exist for disseminating Public Advisories or Hurricane Local Statements to communities. The State has a limited role in disseminating NWS products because it does not have a dissemination system capable of simultaneously sending hardcopy warning messages to threatened communities in real time. For this reason, regardless of the threat posed by an approaching hurricane, State emergency management officials use telephones and Fax machines as the primary means of relaying the information received from the NWS to local officials. The State encourages local officials to monitor NWR broadcasts and to contact NWS officials directly rather than depending upon State officials to Fax Public Advisories and Hurricane Local Statements to them.

Immediately after a hurricane watch or a hurricane warning has been issued for Connecticut, the CTOEM coordinates with the State Police at the State Warning Point in Meriden to relay these warnings over State NAWAS. This dedicated phone system is linked to the State and County Fire Radio Systems. Warning messages that originate from the State Warning Point over State NAWAS can be relayed to each

local fire department by County Fire Radio dispatch centers. The utilization of State NAWAS for weather warning is generally limited to notification of hurricane watches and hurricane warnings, or for warning of other weather related threats which present immediate danger, such as tornadoes and flash floods.

The State has indicated that voice systems linked by dispatch centers are generally not reliable or efficient for relaying lengthy detailed weather forecasts. Moreover, the State has concluded that messages sent over State NAWAS and re-dispatched over the County Fire Radio system are uncontrollably fanned out to all regions of the State. State officials fear that excessive dissemination of coastal specific weather information and coastal evacuation recommendations to all regions of the State, including areas for which messages are not intended, may cause confusion. For this reason State emergency management officials refrain from using State NAWAS and the County Fire Radio System for disseminating weather information, but instead, they rely on the use of telephones and Fax machines.

After initial hurricane advisories are issued over State NAWAS, State emergency management officials further coordinate with Connecticut's State Police to send follow-up, hardcopy hurricane forecast information over the Connecticut On Line Law Enforcement Communication Teleprocessing (COLLECT) system. COLLECT is a statewide computer information system which has the primary function of providing law enforcement officials with information on arrest warrants and criminal profiles. The system uses commercial telephone lines and computer terminals to link local police departments to the State Police headquarters. Of the 25 coastal communities in Connecticut, 22 have COLLECT links at their police department headquarters (East Lyme, Old Lyme, and Westbrook are the three which do not).

Presently, officials at the State EOC do not have direct COLLECT transmitting capabilities, therefore any messages State emergency management officials intend to send over COLLECT must first be conveyed by telephone or Fax machine to the State Police at the State Warning Point. Once the State Police receives these messages they prioritize the messages based on their importance and send these messages as the system becomes available. Consequently, the present use of COLLECT for hurricane preparedness is inefficient and inconvenient. When COLLECT is used to disseminate NWS products, information contained in products is usually paraphrased for conciseness to improve message sending efficiency and reduce the total time the system is occupied for emergency management purposes. The frequency and time intervals that COLLECT is used for disseminating weather information is generally sporadic due to inefficiencies in manually inputting information into the system and competition for the system by State Police and emergency management officials. Consequently, State emergency managers depend more upon telephones and Fax machines for disseminating NWS forecasts to local officials than on the COLLECT system.

In an attempt to remedy inefficiencies when using COLLECT, the CTOEM has initiated a proposal to install an automated link between NWWS and COLLECT. Many States have already integrated their State Law Enforcement systems with NWWS, and NWS officials of southern New England have encouraged the State of Connecticut to do the same. A single automated junction at the State Warning Point will bolster the ability of the Governor and State emergency management officials to provide crucial advance weather warning and forecasts to municipalities and the public. Without this link, State emergency management officials will continually be faced with inadequate weather dissemination abilities that could potentially lead to serious consequences.

State emergency management officials maintain continuous communication with most coastal emergency managers through the use of high band, two-way radio networks. Radio communication has proven to be an excellent way for State officials to be kept informed of local preparedness and recovery situations, but radio networks are not reliable for relaying detailed NWS products.

In summary, the lack of a dedicated dissemination system, which has the capability to quickly relay NWS products in their entirety to local emergency management officials, has led to policies adopted by the State to best use current systems. State officials send redundant hurricane watch and warning messages over NAWAS, State and County Fire Radio Systems, COLLECT, and by telephone to help ensure that at a minimum, at least one official from each threatened community is made aware of the potential hazard. Additionally, emphasis has been placed on the need for community officials to monitor NWR broadcasts. With regard to disseminating State hurricane preparedness recommendations and distributing NWS products received over NWWS, telephones and Fax machines are currently the most reliable, and consequently remain the primary system used by State and local emergency management officials.

Rhode Island's Dissemination Systems and Procedures

The RIEMA, as part of its State Warning Plan, has specifically outlined standard procedures that are executed by State and NWS officials to locally disseminate hurricane preparedness information in the hours before a storm's landfall. Depending upon the threat posed by the approaching storm, various warning and communication systems are activated and used. During low threat periods, prior to the NHC issuing a hurricane warning for Rhode Island, State and local emergency management officials rely upon NWS Special Weather Statements automatically sent over the State Police Rhode Island Law Enforcement Telecommunication System (RILETS) and the NWR to keep them informed of the latest hurricane developments. In addition, State officials frequently contact the MIC at the WSO Providence for more detailed weather outlooks, and they encourage affected local officials to do the same.

Once a hurricane's threat becomes more likely and the NHC has issued a hurricane warning for Rhode Island, RILETS continues to be the primary warning and dissemination system. This system provides 24 hour warning service to each local warning point in the State. All of the coastal communities have local warning points and receive this service through the cooperation of the Rhode Island State Police.

The Rhode Island State Police, RIEMA, and the WSO Providence all have RILETS receiving and transmitting capabilities. It has been cooperatively agreed that the WSO Providence will assume responsibility for disseminating NWS products over RILETS. An automated link between RILETS and the NWS at the WSO Providence enables specific weather products to be sent as they are received. Prearrangements made by State and NWS officials help to ensure that NWS products are sent to local officials at regular time intervals, in real-time, without redundancy or conflicts. The automated link between these systems eliminates cumbersome retyping and re-transmitting of weather advisories, and results in products being received with their original format and content intact.

The WSO Providence uses RILETS to relay all NHC Public Advisories and Marine Advisories, as well as their own Hurricane Local Statements. They also coordinate with State emergency management officials for activation of the State NAWAS to warn all officials immediately when Rhode Island is included within hurricane watch or hurricane warning limits. Initial warnings relayed over NAWAS also serve as notification to local officials in Woonsocket, Westerly, and Newport that more detailed weather warnings have been relayed over RILETS and can be retrieved at local police department headquarters. State NAWAS has a very limited role in disseminating hurricane preparedness information, other than its use as an initial hurricane warning system or possible backup system.

The Civil Defense State Radio System (CDSTARS) is a voice communication system with the primary purpose of linking communications between the State EOC and community EOCs. Historically CDSTARS has not been used by the State to relay details of NWS products, but rather as a system which is used in support of RILETS. Community EOCs, which are not located at police departments, may not receive RILETS messages unless emergency managers actively pursue messages sent to local police over the system. An information flow break down may occur if emergency managers are not made aware of RILETS messages received by their police departments. In light of this, the State EOC and the WSO Providence use CDSTARS to notify emergency managers when RILETS messages are sent to communities. The State recognizes other warning and information dissemination systems as part of the State Warning Plan, but RILETS and CDSTARS are the two which are most prominently used for hurricane preparedness purposes. The State encourages all those with a need to receive weather information to purchase and use NWR receivers as an alternative method to receive NWS broadcasts. To assist in this, the RIEMA lends its technical support to maintain Rhode Island's NWR station.

Southern Massachusetts' Dissemination Systems and Procedures

The MEMA's headquarters is located at the State EOC in Framingham. It is supported by four area emergency management offices which divide the State's municipalities into jurisdictions. These area offices have similar responsibilities as area offices in Connecticut, but in addition their areas are further divided into smaller jurisdictions managed by section directors. Communities along the southern Massachusetts coastline, including those communities on Cape Cod, Martha's Vineyard, Nantucket, and the Elizabeth Islands are a portion of the 92 communities served by MEMA's Area II office located in East Bridgewater, Massachusetts.

Although New England local governments are typically managed on municipal levels rather than on county levels, county law enforcement officials on Cape Cod, and the islands of Martha's Vineyard and Nantucket have an important role in hurricane preparedness. Area II officials coordinate directly with county law enforcement officials and community officials. Involvement on the part of county officials helps to instill county-wide evacuation decisions rather than independent evacuation decisions made by each community.

A NWWS terminal at the State EOC is the primary means used by State officials to obtain information on developing hurricanes. The State receives the NHC's Public Advisories and Hurricane Local Statements from the Boston WSFO but the State's NWWS subscription does not include the NHC's Marine Advisories. Frequent telephone conversations between Boston WSFO officials and MEMA officials enable the State to obtain information routinely provided in Marine Advisories.

The MEMA presently does not have a system for disseminating hardcopy NWS products directly to communities other than by Fax. MEMA officials must contend with the frustrating situation of receiving information vital to communities yet not having an effective means for quickly disseminating the information to local officials. At the local level, officials must depend upon NWR broadcasts, the media, forecasts Faxed by the State, and voice communication systems to receive information to base their community evacuation decisions.

The State is working to link the State Police Criminal Justice Information System (CJIS) to the NWWS. A junction between these systems will enable all local police departments linked to CJIS (500 locations throughout the State) to receive hardcopy Hurricane Local Statements and Public Advisories as they are issued by the NWS. Until this link is established, the NWR will continue to remain the primary means for local officials to access NWS forecasts. In an attempt to supplement forecast information received at the local level, the MEMA has adopted a system of disseminating forecasts and warnings on a limited basis by telephones, Fax machines, and voice warning systems.

As part of the State's hurricane preparedness procedures, the MEMA and the Boston WSFO use State NAWAS to warn emergency managers, police and fire officials throughout the State of initial hurricane watches and warnings issued for Massachusetts. Weather warnings issued over NAWAS are heard at 26 NAWAS terminals. NAWAS warning messages are further disseminated to local officials by two-way radio networks and commercial telephones. The MEMA has recently undertaken a major overhaul of State NAWAS such that it will be linked to all County Fire Radio dispatch centers throughout the State. Once system modifications have been completed, State NAWAS messages will be relayed to all of the State's fire departments by re-transmission of warnings at County Fire Radio dispatch centers.

The MEMA maintains and operates extensive two-way radio networks which are heavily used for upward reporting by communities, and used for dissemination of general evacuation recommendations made by the State. Statewide Radio provides communication links from the State EOC to each area office, other at State agencies, and some local civil defense headquarters. Radio Amateur Civil Emergency Service (RACES) and high band radio networks are other established systems which are also used for State and community communications. The State has no standard procedures for using these systems to disseminate NWS forecasts.

V - CONNECTICUT'S RESPONSE TO HURRICANE BOB

State Officials

On the afternoon of August 18, 1991, Connecticut's State EOC underwent partial activation and State emergency management officials began monitoring Hurricane Bob's progress using NWS products received over the NWS. As the threat increased that evening and into the following morning, State officials accomplished full activation of the State EOC by 7:00 a.m. on August 19. State emergency management officials sponsored situation briefings for officials from the Governor's office; State Police; Departments of Transportation, Environmental Protection, and Public Utilities Control; the National Guard; as well as personnel from utility companies, and other interests. Based on their discussions, NWS forecasts, and community preparedness status reports, the Director of the CTOEM determined that the expected danger posed by Hurricane Bob could be adequately dealt with by communities with little State intervention. Consequently, the Director of the CTOEM did not make a State of Emergency recommendation to the Governor, and consequently, a State of Emergency was not declared.

The State did not make recommendations to communities to conduct public evacuations nor did they suggest that local businesses temporarily close. However, the State did disseminate NWS products to communities in support of local decisions. Both, NAWAS and COLLECT were used to disseminate hurricane watches and hurricane warnings, but only COLLECT was used sporadically to send paraphrased NWS forecast information to communities.

The Area 4 EOC in Colchester and the Area 2 EOC in Meriden, were fully activated by 7:00 a.m. and 10:30 a.m., respectively, on August 19. Both of the area coordinators indicated that their EOCs were partially activated prior to these times, and that limited staffing impeded activities once their EOCs became fully operational. In addition to routine upward reporting by local officials of their community preparedness status, area coordinators Faxed forecasts which they had received from the State EOC to communities. Area coordinators, by two-way radio or telephone follow-up conversations, ensured Fax messages had actually been received by local emergency managers.

Local Officials

Activation of Community EOCs

Local officials in southeast and south central Connecticut generally activated their EOCs a few hours before Hurricane Bob's landfall after weather conditions had already deteriorated. Community EOCs were activated "late" (or after weather had deteriorated) despite high landfall probabilities issued by the NWS several hours before landfall. Table 4 compares the number of communities that had activated

their EOCs to the landfall probabilities issued for major cities located near Connecticut. In the table, comparisons are given at four instantaneous times within a 26 hour period prior to landfall. As shown, as of eight hours before eye landfall, only five of the 14 communities had partially activated their EOCs, and none had been fully activated.

Late EOC activations are perhaps due to the fact that officials did not receive the forecasts and landfall probabilities issued by the NHC in the Marine and Public Advisories. If the NHC's landfall probabilities and forecasts had been known by local officials, community EOCs may have been activated sooner. Comments made by a few officials that their community's EOC activation was based on forecasts which predicted time of landfall to occur late in the evening of August 19 suggest that local officials either listened to forecasts from sources other than the NWS (the media), or they received early forecasts made by the NWS but did not receive subsequent updates.

Receipt of Warnings and Advisories

The 14 officials who were interviewed were specifically asked which sources (i.e. the State, NWS, media, private weather vendors, etc.) provided hurricane information to them, how that information was relayed, and how often information was received. Most local officials said their community primarily used forecasts received from the CTOEM, NWS, and the media. Few relied on private weather vendors or other sources.

The primary weather source used by local officials varied widely by community. Some local officials attempted to monitor all available sources on a continual basis for two reasons. First, officials were uncertain of what information each source provided. Second, they were unsure of the scheduled times these sources issue information and updates. The fear of missing an important weather update or not being aware of any sudden changes in the Hurricane's forecast are some reasons cited by officials for eagerly monitoring all available sources. Some officials who were confident in the forecast capabilities of a single source tended not to monitor other sources.

All 14 communities involved in interviews reported receiving State issued warnings and weather reports. Three local officials said they received fewer than three State issued messages compared with six others who said they had frequently exchanged information with the State. Most officials said State reports were issued at random, or at irregular time intervals. Four officials stated they obtained information from the State at least once every six hours.

Most communities reported receiving State reports by several means. Nine local officials reported telephones as a primary means of communicating with the State, seven cited Fax machines, seven cited two-way radios, and five cited

COLLECT. State issued reports, as well as information from other sources, were probably received by local officials of many different departments (police, fire, public works, emergency management) within communities. Messages received by community police departments or fire departments may not have been sent to or relayed to community EOCs. Evidence of this is shown by comparison of the total number of communities that reported receiving COLLECT messages to the total number of communities that COLLECT messages were sent to. Five of the 14 local officials reported that their communities had received COLLECT messages, yet the State indicated that COLLECT messages were sent to 11 of the 14 communities. This discrepancy is further explained by local officials' comments that police departments received hardcopy forecasts from sources which were unknown to them.

Communities tended to rely on the television news media and cable weather channels for weather forecasts more than on NWR broadcasts. Twelve officials reported using television as a source compared to five officials that reported relying upon the NWR. Some officials commented that cycle times of NWR forecasts were lengthy and that forecasts provided by cable channels and other networks were more frequently updated and more convenient to use. Six of eight officials that indicated that the NWR was not monitored also indicated that NWS forecasts were either received from the State over COLLECT or from the NWS directly by telephone. In total, 11 of the 14 communities interviewed reported receiving NWS forecasts despite the fact that only five communities reported that NWR broadcasts were monitored.

Evacuation Decisions

Local officials from Connecticut's southeastern and south-central coastal communities took different preparedness actions even though each community faced the same hazard posed by Hurricane Bob. In fact, some communities conducted evacuations the evening of August 18, some on the morning of August 19, and some made no public evacuations. As shown in Table 5, within four to six hours of eye landfall at Newport, Rhode Island, nine of 14 communities issued evacuation recommendations for areas within their communities. No community officials ordered residents to evacuate. However, officials generally made evacuation recommendations to the public and provided assistance during evacuations to those people who needed it.

Four local officials reported the State told them that they should conduct public evacuations compared with nine that clearly stated that no such recommendation was issued by the State. Two local officials stated that a State evacuation recommendation was a partial basis for which their community evacuation decisions were made. The majority of other officials said that community evacuation decisions were based upon knowledge of their community's historic flooding, and on warnings broadcasted by the media. One official said his community's response was based upon information received through computer links to a private weather vendor, and one other relied upon field observations made by emergency personnel stationed along the community's coast.

With regard to business closure recommendations, only two communities of the 14 made suggestions to local businesses in hazard areas. Emergency management officials of these two communities warned caretakers of businesses of potential flooding in their areas, but officials left the decision of whether businesses should remain open or close to individual caretakers.

Notification of Public Evacuations and Shelters Facilities

Local officials from the nine communities said that the areas which were recommended to be evacuated were determined hazardous based upon knowledge of past flooding experiences. Only two officials cited their community's National Flood Insurance Program maps as tools used for determining areas to be evacuated. Only a few of the officials indicated that the FEMA/Corps of Engineers' draft inundation maps and draft evacuation maps were used as references, and none of the officials reported using the draft maps for identifying vulnerable areas that should be evacuated. Several officials said that they had estimated, before Hurricane Bob's arrival, that potential flood hazards would be minimal and therefore large scale evacuations were not warranted. Consequently, most officials limited evacuation recommendations to the most vulnerable homes in low-lying areas closest to the coast.

Broadcasts of evacuation recommendations over public address systems and "door to door" notification were the most commonly used methods by officials for warning the public and notifying them of public shelters. Several officials reported that evacuation recommendations and public shelter information were incorporated into news broadcasts of local television and radio networks.

Table 5 lists estimates made by local officials of the total number of evacuees that used public shelters in their communities. Total shelter usage numbers of some communities exceeded the total population evacuated because some people sought public refuge even though they were not specifically recommended to do so. A portion of the added demand for public shelters is due to motorists passing through communities who elected to stay in public shelters until the Hurricane passed. However, in most cases, variations in these figures are attributed to community residents who evacuated and sought public shelters under their own volition. When local officials were asked to what degree did they recommend that residents seek public shelters, most said that only those residents who were personally recommended to evacuate were encouraged to use shelters. Officials said they did not encourage residents, who live outside flood-prone areas, to seek public refuge because officials believed they would have been placed in more danger while traveling to shelters than if they had remained in their homes.

Table 4 - Hurricane Threat versus Southeastern Connecticut's Community EOC Activation

| Date & Time | Approx. Eye Location | NWS Issuance in Effect | Probability of Landfall within 65 miles of | | | Community EOC Activation | |
|-----------------------|--|---|--|----------------|------------|--------------------------|---------------------|
| | | | New York, NY | Providence, RI | Boston, MA | # Partial Activated | # Full Activated |
| August 18 12:00 PM | 220 miles east of Charlestown, SC | Hurricane Watch issued for parts of Southern New England | 19% | 20% | 18% | 1 | 0 |
| August 18 6:00 PM | 120 miles east of Wilmington, NC | Hurricane Warning issued for parts of Southern New England | 26% | 33% | 30% | 3 | 0 |
| August 19 6:00 AM | 90 miles east of Ocean City, MD; Eye 220 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 5 | 0 |
| August 19 8:00 AM | 100 miles east of Cape May, NJ; Eye 160 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 1 | 7 |

- NOTES: 1. EOC activations totals based on responses of local officials from 14 communities.
2. Landfall probabilities based on the NHC's Public Advisories issued for Hurricane Bob.
3. Landfall probabilities for 8:00 AM on August 19 are based on the Public Advisory in effect at 6:00 AM on August 19.

Table 5 - Southeastern Connecticut Evacuating Population and Public Sheltering Estimates

| Community | Public Evacuation Recommendation Issued | Number of People Recommended to Evacuate | Number of People Seeking Public Shelters |
|--------------|---|--|--|
| Branford | no | 0 | 0 |
| Clinton | yes | 100 | 30 - 40 |
| East Haven | no response | - | - |
| East Lyme | yes | 20 | 300 |
| Groton City | yes | 100 | 76 |
| Groton Town | yes | 3000 | 650 |
| Guilford | no | 0 | 10 |
| Madison | no | 0 | 20 |
| New Haven | no | 0 | 12 |
| New London | no | 0 | 35 |
| Old Lyme | yes | <12 | 50 - 60 |
| Old Saybrook | yes | 500 | 500 |
| Stonington | yes | 300 | 500 |
| Waterford | yes | 100 | 60 |
| Westbrook | yes | 500 | 150 |

Evacuation Timing and Traffic Considerations

Even though most evacuation decisions were made after weather conditions had deteriorated, there was still ample time before landfall for local officials to complete evacuations. In all communities where evacuations were conducted, residents were notified of evacuation recommendations, mobilized, and traveled to safe designations in less than four hours time. Only one community reported that localized traffic congestion slightly increased time required for evacuation, all others reported that no traffic congestion was experienced

VI. - RHODE ISLAND'S RESPONSE TO HURRICANE BOB

State Officials

RIEMA officials began monitoring Hurricane Bob's development and progress to the Northeast three days before its landfall. Prior to the NHC's issuance of a hurricane watch for Rhode Island, State emergency management officials primarily focused on assimilating forecasts contained in Public and Marine Advisories, weather broadcasts of three major television networks and also, the Weather Channel. NWS products were received at the State EOC by the NWWS, RILETS, and the NWR. Discussions between the RIEMA officials and NWS officials were held so that State officials clearly understood forecasts and the threat posed by Hurricane Bob. RIEMA officials kept the Governor's office advised of forecasts and the hurricane preparedness readiness at the State and local levels. Also, through live media broadcasts from the State EOC, emergency management officials kept the general public aware of Rhode Island's vulnerability, the preparedness actions taken by the State and by some communities, and additional preparedness actions that were being considered at that time.

The RIEMA fulfilled its responsibility to disseminate NWS information to local officials by enabling the WSO Providence to send all Public Advisories, Marine Advisories, and Hurricane Local Statements to communities over RILETS. Immediately after a hurricane warning was issued for Rhode Island at 6:00 p.m. on August 18, the WSO Providence began continuous dissemination of NWS products over RILETS until Hurricane Bob passed. Prior coordination between the RIEMA, Rhode Island State Police, and the NWS made this information flow to communities possible.

The State EOC was activated at 1:00 a.m. on August 19. In the absence of the Governor, the Lieutenant Governor, after first receiving recommendations from the Director of the RIEMA, declared a State of Emergency for the entire State at 6:30 a.m. on August 19. The State EOC became fully activated at 7:30 a.m., one hour after the Lieutenant Governor's declaration. State officials made general recommendations to local officials that public evacuation of flood-prone areas should be conducted, and that nonessential government offices, private businesses, and schools should temporarily close. As weather conditions continued to deteriorate, the NWS continued disseminating its products over RILETS while State emergency management officials primarily used telephone communication and CDSTARS to receive community reports and make general recommendations to local officials. By approximately 9:00 a.m., the State reported that all citizens living in flood threatened, low-lying areas had been evacuated.

Local Officials

Activation of Community EOCs

The majority of local emergency managers from Rhode Island's coastal communities activated their EOCs on the evening of August 18. The data in Table 6 shows that, by the time a hurricane warning had been issued for Rhode Island at 6:00 p.m. on August 18, six of 19 coastal communities had already partially or fully activated their EOCs. The Public Advisory issued by the NHC at this time indicated that Hurricane Bob had a 33 percent chance of passing within 65 miles of Providence, Rhode Island. By 6:00 a.m. on August 19, 18 of 19 coastal communities reported having their EOCs activated. By 8:00 a.m. that same morning, all 19 communities that were interviewed reported their EOCs had been fully operational.

Receipt of Warnings and Advisories

Nearly all local emergency managers identified the RIEMA, NWS, and the media as their primary sources for obtaining forecasts which they needed for assessing their communities' likelihood of being impacted by Hurricane Bob. Only one local official reported using a private weather vendor as a primary source.

With regard to communications between the RIEMA and the communities, 17 of the 19 officials noted having contact with State officials. Two local officials specifically stated that they did not have any contact with the State, however they were not certain whether other officials within their communities had. Eight of the 19 officials said that within 24 hours before Hurricane Bob's arrival, communication between their communities and the State occurred at less than two hour intervals. Seven said contact with State officials was random but the frequency which they communicated with State officials increased as the Hurricane approached. Two officials said State contact occurred once every two to four hours. When officials were asked what the predominant method of communication was between the State and their community, most responded two-way radio (CDSTARS) and telephone.

Of the 17 officials that had contact with the RIEMA, 13 said the State recommended that public evacuations be conducted. Three of the 17 officials said that a State public evacuation recommendation was not made; and one official was uncertain of whether the State recommended communities conduct public evacuations, or not. Two officials commented that the State did not act quickly enough and that the State should have activated the State EOC sooner. Some officials said they heard reports communicated over CDSTARS but they were confused about who the reports were intended for and which source was issuing the reports.

Local officials said they relied upon the NWS and television news on nearly an equal basis for weather forecasts. Seventeen officials said they received forecasts directly from the NWS, compared with 19 officials that said they monitored the media for forecasts. Of the 17 officials that received NWS forecasts, 11 said RILETS was the primary communication system used; 10 said CDSTARS; 4 said the NWR; and 3 said direct telephone communications. Most officials said the frequency at which NWS forecasts were received was, on average, less than one forecast every two hours after the hurricane warning had been issued.

Nine officials reported that the NWS recommended that public evacuation of coastal and riverine flood-prone areas be conducted. Some officials said that "detailed weather forecasts" had been received from local police authorities, yet they were uncertain of how the local police had obtained the forecasts. Two local officials said police authorities "bypassed" the emergency management departments of their communities by neglecting to provide emergency management officials with copies of the forecasts sent over RILETS. These comments indicate there may be some confusion at the local level as to the role the Providence WSO has in disseminating NWS products over RILETS. Furthermore, it may not be understood by some local officials that NWS products sent over RILETS are intended to be further disseminated to other local officials in their communities.

Evacuation Decisions

Public evacuations were conducted in all 19 of the communities interviewed. Table 7 lists estimates made by local officials of the total number of people in each community recommended by officials to evacuate. In communities where broad evacuation recommendations were issued to large portions of the population, local officials were not able to make confident estimates of the total numbers of people that actually evacuated. In communities where small numbers of people were recommended to evacuate, officials said the number of people that actually evacuated was in most cases nearly the same as the number of people recommended to do so. In communities where fewer people were told to evacuate, recommendations were usually made to very specific areas by "door to door" notification. Officials indicated that residents who were personally directed to evacuate tended to evacuate their homes more often than those who received evacuation recommendations by radio or television.

Most local officials said residents were told to evacuate their homes more than six hours prior to eye landfall. As many as seven communities arrived at decisions to evacuate the day before landfall or in the early hours on the morning of the storm. Only three communities waited to conduct public evacuations until four hours prior to eye landfall.

Local officials' decisions whether to issue evacuation recommendations to the public were based on suggestions made by the RIEMA, NWS, the media, and their knowledge of past flooding experiences of their communities. Some officials compared the forecasted intensity of Hurricane Bob to that of the 1938 Hurricane in order to decide how far inland from the coast public evacuations should be conducted. When officials were asked what source was used to base their decisions, seven responded recommendations made by the RIEMA; three said NWS recommendations; and two said information broadcasted by the media. The other seven of the 19 officials cited their knowledge of past flooding and/or community developed hurricane response plans as the primary information used for basing evacuation decisions.

With regard to local businesses, 13 officials said business closure recommendations were made to either the majority of community businesses or to specific waterfront businesses only. Local radio and television broadcasts were used by six communities as the primary means of issuing business closure recommendations. Six other officials reported that "door to door" notification and broadcasts of business closure recommendations from emergency vehicles were the most commonly used notification methods.

Notification of Public Evacuations and Shelter Availability

In communities where broad evacuation recommendations were issued, most local officials described the areas that the public should evacuate by announcements such as "evacuate along low lying areas near the shore and rivers" or "waterfront homes exposed to waves should evacuate" issued over local radio and television. Broadcasts were supplemented by evacuation announcements sent over public address systems of emergency vehicles and "door to door" notification. Sixteen communities used "door to door" notification, 14 used public address systems, and 10 used local radio, local television, or both. Only four communities said that the FEMA/Corps of Engineers' draft inundation maps and draft evacuation maps were tools used for determining which areas were most vulnerable to flooding.

Local officials generally did not encourage evacuees to seek refuge at public shelters because communities suffered from inadequate shelter capacity due to logistical shortfalls of the American Red Cross. Officials said facilities which were supposed to be opened and operated by the American Red Cross were not opened on time because American Red Cross personnel either arrived late or did not show up at all. Table 7 provides estimates made by local officials of the total numbers of evacuees sheltered in each community.

Table 6 - Hurricane Threat versus Rhode Islands' Community EOC Activation

| Date & Time | Approx. Eye Location | NWS Issuance in Effect | Probability of Landfall within 65 miles of | | | Community EOC Activation | |
|-----------------------|--|---|--|----------------|------------|--------------------------|---------------------|
| | | | New York, NY | Providence, RI | Boston, MA | # Partial Activated | # Full Activated |
| August 18 12:00 PM | 220 miles east of Charlestown, SC | Hurricane Watch issued for parts of Southern New England | 19% | 20% | 18% | 3 | 1 |
| August 18 6:00 PM | 120 miles east of Wilmington, NC | Hurricane Warning issued for parts of Southern New England | 26% | 33% | 30% | 4 | 2 |
| August 19 6:00 AM | 90 miles east of Ocean City, MD; Eye 220 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 7 | 11 |
| August 19 8:00 AM | 100 miles east of Cape May, NJ; Eye 160 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 0 | 19 |

- NOTES:
1. EOC activations totals based on responses of local officials from 19 communities.
 2. Landfall probabilities based on the NHC's Public Advisories issued for Hurricane Bob.
 3. Landfall probabilities for 8:00 AM on August 19 are based on the Public Advisory in effect at 6:00 AM on August 19.

Table 7 - Rhode Island Evacuating Population and Public Sheltering Estimates

| Community | Public Evacuation Recommendation Issued | Number of People Recommended to Evacuate | Number of People Seeking Public Shelters |
|-----------------|---|--|--|
| Barrington | yes | 400 | 400 |
| Bristol | yes | 200 | 75 |
| Charlestown | yes | 600 - 700 | 300 |
| Cranston | yes | 200 | 100 |
| East Greenwich | yes | > 60 | 60 |
| East Providence | yes | 200 | 80 |
| Jamestown | no response | - | - |
| Little Compton | yes | 100 - 150 | 150 |
| Middletown | yes | 75 - 100 | 70 |
| Narragansett | yes | < 1000 | 500 |
| New Shoreham | no response | - | - |
| Newport | yes | 5000 | 650 |
| North Kingstown | yes | 1500 | 1500 |
| Pawtucket | yes | 20 | 20 |
| Portsmouth | yes | 600 | 230 |
| Providence | yes | 450 | 265 |
| South Kingstown | yes | 8000 - 10000 | 950 |
| Tiverton | yes | 1000 | 200 - 300 |
| Warren | yes | 100 | 200 |
| Warwick | yes | 1500 - 2000 | 850 |
| Westerly | yes | 5000 | 950 |

Evacuation Timing and Traffic Considerations

Nearly all officials reported that it required less than eight hours for all evacuees to reach safe locations after community evacuation decisions were made. Twelve officials reported it took less than four hours for their evacuation to be completed. Evacuation time includes: time required by officials to issue evacuation recommendations to the public, time required for the public to respond to recommendations, time for officials to help evacuate people requiring assistance, and time for evacuees to travel to safe destinations. Only one official said that traffic congestion led to an increase in his community's overall evacuation time. All other communities reported no traffic congestion other than one that had noted a minor localized delay of less than one half hour.

VII - MASSACHUSETTS' RESPONSE TO HURRICANE BOB

State Officials

In response to the NHC's hurricane watch and warning issued for parts of southern Massachusetts, and discussions held with NWS officials at the Boston WSFO, MEMA officials partially activated the State's EOC at 6:00 p.m. on August 18. The State received Public Advisories as well as Hurricane Local Statements from the Boston WSFO, however the State did not receive Marine Advisories. Telephone conversations held between MEMA and NWS officials allowed extended forecasts provided as part of the Marine Advisories to be available to the State. As the prospect of Hurricane Bob's threat increased throughout the evening of August 18, the State's EOC became fully operational by 6:00 a.m. on August 19.

Typically, either the Boston WSFO, Massachusetts State Police, or the MEMA activate State NAWAS to alert all officials in the State of hurricane watches and warnings. At the time Hurricane Bob occurred, State NAWAS was not operable and therefore it had not been activated. On the morning of August 19, the NWS told the MEMA that coastal areas might experience severe flooding and that evacuations of some areas may be required. The State, through the Area Directors, urged local emergency managers to enact hurricane preparedness procedures outlined in their Comprehensive Emergency Management Plans.

In addition to warnings issued by area directors to the communities, at approximately 8:45 a.m. on August 19, warnings originating from the State EOC were relayed by the State Police to county sheriff departments and local police departments over the Law Enforcement Agency Planning System (LEAPS). Warnings informed communities to "start evacuation procedures of low lying areas, including coastal areas, summer camps, camping areas and trailer parks". This recommendation was further relayed to communities without LEAPS terminals by telephones, Fax machines, RACES, and the State Radio.

Through media broadcasts from the State's EOC, State officials gave general warnings to the public and aired recommendations that businesses should temporarily close. The Emergency Broadcast System was also activated. The Lieutenant Governor, in the absence of the Governor, declared a State of Emergency at 9:30 a.m. after receiving recommendations from the MEMA's director.

Local Officials

Activation of Community EOCs

Most of the officials interviewed reported that their community's EOC was activated late in the evening on August 18 or early in the morning on August 19. As shown in Table 8, at the time a hurricane warning was issued for southern Massachusetts at 6:00 p.m. on August 18, only nine of 28 communities had partially activated their EOCs. None of the communities reported that their EOC had undergone full activation at this time. Some officials explained that their EOCs were not activated sooner because their decisions to activate EOCs were based upon forecasts which indicated Hurricane Bob would not make landfall until late in the evening on August 19 or early on August 20. By 8:00 a.m. on August 19, 21 of 28 communities had either partially or fully activated their EOCs.

Receipt of Warnings and Advisories

Each of the nine communities interviewed along upper and mid-Cape Cod said they had contact with State emergency management officials. Most officials said telephones were the primary method used to communicate with the MEMA, but four of the nine officials also identified two way radios as the primary means of communication. Three officials said they received teletype warning messages sent over LEAPS by the State Police. Although most of these officials said that communications with the MEMA occurred at frequent but random time intervals, three local officials said they had only spoken with MEMA officials either once or twice in the hours prior to the storm. In general, local officials agreed that communications with MEMA officials were in most cases used for upward reporting only. The officials of Cape Cod communities tended to rely more upon weather broadcasts by the media than broadcasts provided over the NWR. Eight of the nine communities reported using media weather information compared with only four that reported obtaining weather information from the NWR or by telephone from NWS officials.

Martha's Vineyard communities indicated they had infrequent contact with the State, however they said they had frequent contact with the Dukes County Civil Defense Director. Dukes County received information from State emergency management officials at time intervals of less than four hours, and information received was further disseminated to the communities of the County. Local officials said that most evacuation decisions were made during a hurricane preparedness planning meeting chaired by the Dukes County Civil Defense Director at 7:00 a.m. on August 19. The decision to evacuate flood vulnerable areas on the Island was made collectively by those officials that attended this meeting. Most Island officials said NWR broadcasts were frequently monitored and that these broadcasts supplemented State information received through the Dukes County Civil Defense Director.

Twelve of the 13 officials interviewed from communities located along the western shore of Buzzard's Bay and along the Taunton River said they had telephone or two-way radio contact with MEMA officials prior to Hurricane Bob's landfall. Most officials said conversations between officials of their communities and the State were generally limited to hurricane warnings issued by the State and for upward reporting of community preparedness status. Three officials said the State recommended that local official should evacuate vulnerable residents, five said no recommendation was made by the State, and four officials were uncertain whether a recommendation had been issued or not. Officials of these communities said they predominantly received weather information from NWR broadcasts, the television media, or from NWS forecasts aired on local cable television.

Evacuation Decisions

Nearly all of the communities that participated in interviews indicated that some level of public evacuation was conducted prior to Hurricane Bob. Table 9 lists by community the responses of local officials when asked to estimate the total number of people, in their community, who were recommended to evacuate their homes. Most officials were able to make gross estimates, but some officials were very uncertain and therefore did not provide estimates. It is important to note that the numbers presented in Table 9 are only estimates of the numbers of people asked to leave their homes and not of the numbers of people that actually left their homes.

On Martha's Vineyard, local officials, in most cases, identified vulnerable flood-prone areas as those areas which had flooded during past storms. Two Martha's Vineyard officials said the National Flood Insurance Program maps and draft hurricane inundation maps were used as tools to help identify areas vulnerable to flooding. Recommendations suggested to Island businesses varied by community. Two officials said that all businesses except select grocery stores and restaurants were recommended to temporarily close. Two other officials said that no recommendations were issued to local businesses. One official said that businesses had responded by closing on their own and that closure recommendations were unnecessary.

Officials from Cape Cod communities reported that an evacuation recommendation issued by MEMA officials was the primary basis for community evacuation decisions. Nine officials said their decisions to evacuate residents were made before 8:00 a.m., approximately six hours before eye landfall at Newport, Rhode Island. Seven officials indicated that draft hurricane inundation maps, draft hurricane evacuation maps, and National Flood Insurance Program maps were references they used to determine flood vulnerable areas to evacuate. Seven of the nine officials interviewed said their communities issued closure recommendations to community businesses. Three officials said all community businesses were recommended to close while the other four officials said only select businesses, mostly those located along waterfront areas, were recommended to close.

Table 8 - Hurricane Threat versus Southern Massachusetts' Community EOC Activation

| Date & Time | Approx. Eye Location | NWS Issuance in Effect | Probability of Landfall within 65 miles of | | | Community EOC Activation | |
|-----------------------|--|---|--|----------------|------------|--------------------------|---------------------|
| | | | New York, NY | Providence, RI | Boston, MA | # Partial Activated | # Full Activated |
| August 18 12:00 PM | 220 miles east of Charlestown, SC | Hurricane Watch issued for parts of Southern New England | 19% | 20% | 18% | 3 | 1 |
| August 18 6:00 PM | 120 miles east of Wilmington, NC | Hurricane Warning issued for parts of Southern New England | 26% | 33% | 30% | 9 | 0 |
| August 19 6:00 AM | 90 miles east of Ocean City, MD; Eye 220 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 10 | 6 |
| August 19 8:00 AM | 100 miles east of Cape May, NJ; Eye 160 miles from New Haven, CT | Hurricane Warning | 40% | 69% | 64% | 4 | 17 |

- NOTES: 1. EOC activations totals based on responses of local officials from 28 communities.
2. Landfall probabilities based on the NHC's Public Advisories issued for Hurricane Bob.
3. Landfall probabilities for 8:00 AM on August 19 are based on the Public Advisory in effect at 6:00 AM on August 19.

Table 9 - Southern Massachusetts Evacuating Population and Public Sheltering Estimates

| Community | Public Evacuation Recommendation Issued | Number of People Recommended to Evacuate | Number of People Seeking Public Shelters |
|--------------|---|--|--|
| Acushnet | no | 0 | 12 |
| Barnstable | yes | 500 | 814 |
| Bourne | yes | 1500 | 1050 - 1150 |
| Chatham | yes | >2500 | 1045 - 1155 |
| Chilmark | yes | - | 56 |
| Dartmouth | yes | 100 | 100 |
| Dennis | yes | - | 3060 |
| Edgartown | no response | - | - |
| Fairhaven | yes | 500 | 140 |
| Fall River | yes | 200 | 225 - 240 |
| Falmouth | yes | 8000 - 10000 | 2100 |
| Gayhead | yes | 75 - 80 | 75 - 80 |
| Gosnold | no response | - | - |
| Harwich | yes | 6000 | 3430 |
| Marion | yes | 400 | 115 |
| Mashpee | yes | 3000 | 260 |
| Mattapoisett | yes | 230 | 280 |
| Nantucket | yes | 3000 | - |
| New Bedford | yes | 1500 | 300 |
| Oak Bluffs | yes | 300 | 300 - 320 |
| Orleans | yes | 400 | 345 |
| Rehoboth | yes | 20 - 25 | 17 |
| Rochester | no | 0 | 50 - 60 |
| Seekonk | yes | 10 | 10 |
| Somerset | yes | 2000 | 90 |
| Swansea | yes | 2000 | 200 |
| Tisbury | yes | - | <300 |
| Wareham | yes | 6000 | 1280 - 1380 |
| West Tisbury | yes | 20 | 300 |
| Westport | yes | 3000 | 110 |
| Yarmouth | yes | 2800 | 4100 |

Public evacuations were conducted in the eleven coastal communities located along the western shore of Buzzard's Bay. The Massachusetts communities located along the Taunton River said public evacuations were not conducted because river front homes in their communities have limited exposure to flooding caused by hurricanes. Most officials said their decisions to evacuate were made earlier than 8:00 a.m. on the morning of the storm. Eight officials reported that their evacuation decisions were primarily based on the MEMA's recommendation to conduct public evacuations. Seven officials said NWS information broadcasted by the media and local cable television was a primary basis for arriving at evacuation decisions. In general, recommendations made to local businesses by communities were consistent. Ten officials from communities where public evacuations were conducted also said that local officials made closure recommendations to community businesses.

Notification of Public Evacuations and Shelter Facilities

Methods used by communities to warn people to evacuate their homes were generally consistent for all communities. Most local officials said that flood vulnerable residents were told through "door to door" notification and by public address warnings broadcasted from emergency vehicles that they were at risk and that they should evacuate. Officials said general warnings and evacuation notices were broadcasted over local radio to supplement their efforts but personal notification methods were most commonly used. People were generally made aware of public shelters at the same time they were being warned that they should evacuate their homes. One Cape Cod official said road signs specifying shelter locations were posted along highways to assist evacuees in finding shelter facilities. Some local officials said that numerous telephone calls were received by residents who asked about their particular threat and what they should do. Business closure recommendations for all areas were in most cases made by radio or television broadcasts. In cases where only select businesses were recommended to close, officials usually made recommendations to business owners by telephone or "door to door" notification.

Evacuation Timing and Traffic Considerations

The Bourne and Sagamore Bridges spanning the Cape Cod Canal were closed to traffic due to high wind gusts at approximately 12:20 p.m., less than two hours before Hurricane Bob made landfall at Newport, Rhode Island. Local officials of neighboring communities opened State facilities to accommodate motorists stranded on highways at the time the bridges were closed. Only four officials interviewed said that more than four hours were needed to complete their evacuations. Most of the evacuation time is comprised of time needed by officials to personally visit residences and issue warnings. Only one community, Barnstable, reported that traffic congestion impeded the evacuation efforts by more than one half hour. Some officials commented that short evacuation times and virtually no traffic congestion were due to the fact that a significant number of people left their homes before officials suggested that they do so, and that many other people chose to "ride out the storm" instead of evacuate.

VIII - EVALUATION OF DRAFT PREPAREDNESS PRODUCTS

General

The Corps of Engineers, New England Division and FEMA, Region I early in the hurricane evacuation study process, developed preliminary hurricane preparedness products for each of the study areas in southern New England. Preliminary products include inundation maps, evacuation maps, and evacuation and shelter data for each community in the study areas. The draft inundation maps delineate the potential worst case flooding that each community could experience for three different hurricane scenarios. Draft evacuation zone maps highlight areas of communities which should be considered for evacuation in the event a hurricane threatens the region. Census data was used to provide preliminary estimates of the number of people living within each mapped zone, and human behavioral hurricane response statistics were applied to population estimates to determine the expected number of people that would evacuate each zone and the approximate number of evacuees that would seek public refuge.

The Corps of Engineers, New England Division and FEMA Region I distributed preliminary mapping and evacuation and shelter data to each of the communities during the summer of 1990. It was determined that preliminary maps and data, although only in draft form and subject to revision, could be used as interim preparedness tools for which local officials could enhance existing community hurricane preparedness plans. Final products to be distributed at the conclusion of the multi-year studies will replace preliminary products and will consider comments received by local officials on interim products. In light of this, Hurricane Bob afforded an opportunity to assess the extent to which interim products were used by local officials in preparing for Hurricane Bob and to determine their effectiveness for local hurricane preparedness activities. Comments received from officials during interviews may ultimately lead to improvements in final hurricane evacuation study products.

Draft Inundation Maps

The degree and purpose for which draft inundation maps were used by local officials prior to Hurricane Bob varied widely by community. Some local officials used their community's map to identify those areas which should be evacuated while others only used them as references. In total, 36 of the 62 communities interviewed from the three States said their draft inundation maps were used for some level of planning prior to Hurricane Bob. Fourteen officials said their community's inundation map was either not available for use, or they were uncertain about the purpose of the inundation maps.

In Connecticut, seven local officials said the inundation maps were used and that they were suitable for their purposes compared with seven officials who said the maps were not used. Most officials who used the inundation maps said they used them as a reference to assess the potential flood hazard. None of the officials used the inundation maps as a means of identifying areas to be evacuated. Four officials said they identified potential flood areas from Hurricane Bob as those areas which were known to flood during past storms.

In Rhode Island, seven local officials said they used the inundation maps prior to Hurricane Bob for assessing potential flooding. Three officials said they defined areas to evacuate as the inundation areas depicted on their community's inundation map. All of the officials that reported using the inundation maps indicated that the maps were suitable for their purposes. Some of the officials who reported not having used the inundation maps explained that other local officials in their communities had specific knowledge of areas which generally flooded during coastal storms. Moreover, these officials reported that the inundation maps overestimated the areas that could have been flooded by Hurricane Bob, and therefore they did not use them. A few officials said they were not aware that the inundation maps were received and a few others said they received the inundation maps but they had misplaced them.

Nearly two thirds of all the Massachusetts local officials interviewed used the inundation maps for assessing potential flooding, identifying areas that should be evacuated, or for determining evacuation routes. All local officials who used the inundation maps said they were suitable for their purposes. Many officials indicated that the draft inundation maps were very useful to them and that they are very interested in obtaining the final inundation map atlas. Several Cape Cod officials cited the NWS forecasts and an evacuation recommendation made by the State, coupled with the flooding information shown on the inundation maps as the primary bases for making their community evacuation decisions. Inundation maps were distributed to all of the communities in the study area however, most of the officials that reported not having used them said they did not have the maps available.

Draft Evacuation Maps

Evacuation maps were not used as frequently by local officials during Hurricane Bob as the inundation maps were. Twenty-four of 62 local officials reported using the evacuation maps compared with 36 officials who used the inundation maps. Those local officials who used the evacuation maps said they were mostly used as reference and that they had been suitable for that purpose.

Evacuation maps developed as part of hurricane evacuation studies are intended as tools for emergency managers to serve two purposes. First, the maps graphically illustrate the zones considered when deriving vulnerable population totals and public shelter capacity requirements. Secondly, they serve as an easy to use tool designed to aid local emergency managers in communicating to the public the areas

of their communities which may require evacuation. In Massachusetts, ten local officials indicated that the evacuation maps were used for their intended purpose compared with only two local officials from Rhode Island, and none from Connecticut that said maps were used as intended.

Of the officials that reported not using the evacuation maps, most stated that in their opinion it was not necessary to evacuate to the degree indicated by the map's evacuation zones because Hurricane Bob did not pose a significant flooding threat to most people living within the zones. Some officials said that prior to Hurricane Bob they had redefined their own evacuation zones based on areas which they believed to be most vulnerable to coastal flooding. Most local officials agreed that the evacuation maps developed by the Corps of Engineers and FEMA are effective tools for worst case hurricane preparedness planning, but most said that in less severe hurricane circumstances, as during Hurricane Bob, the draft evacuation maps greatly overestimate areas which should be evacuated.

Preliminary Evacuation & Public Shelter Data

A majority of local officials said preliminary evacuation estimates and shelter capacity estimates were not used for Hurricane Bob. Most officials stated their reasons for not using this information were either that the preliminary estimates were in draft form and had not been clearly documented in a report, or that they were unaware that their community had received this information. Most officials who said they used the preliminary information for planning prior to Hurricane Bob indicated that it overestimates the number of people who will leave from evacuation zones and it overestimates the number of people that will seek public shelters.

Regardless of whether officials had used the preliminary evacuation and shelter capacity data or not, each official was specifically asked if, in their opinion, preliminary estimates accurately represent the numbers of people that would evacuate and the numbers of evacuees that would seek public shelters in worst case hurricane evacuation scenarios. A majority of the officials said the data does accurately represent worst case scenarios, but many commented that in less significant events, such as Hurricane Bob, estimates are inaccurate and unrealistic. Conversely, a few Massachusetts local officials from communities with large changes in summer time populations due to tourist influx indicated that these estimates may in fact underestimate actual figures. Some officials commented that similar information was developed by officials from their communities and that they believe their estimates to be more preferable. Estimates developed by local officials were based on actual statistics which they had derived from past coastal storms.

IX - CONCLUSIONS & RECOMMENDATIONS

The main purpose of this study is to define the existing hurricane preparedness procedures used at the Federal, State and local levels of government in Connecticut, Rhode Island, and southern Massachusetts, and to identify the actions and recommendations that actually took place prior to Hurricane Bob's landfall. The interrelationship between State and local officials concerning the dissemination of NWS hurricane advisories and forecasts, the issuance of evacuation recommendations, and the methods used by officials to encourage residents to evacuate are important factors which need to be considered before the results of hurricane evacuation studies are implemented in these areas.

The hurricane evacuation study process first began in 1981 when FEMA and the Corps of Engineers provided technical assistance to State and county emergency management officials in Mississippi, Alabama, and Florida. A similar study methodology has been used for many east and Gulf coast States, Hawaii, the Virgin Islands, and Puerto Rico. The fact that evacuation decisions in New England are conducted principally at the municipal government level makes study areas of New England unique. In most other study areas, county officials make public evacuation decisions for all county areas and the actions required in support of their decisions are carried out by officials of each municipality or township.

Hurricane Bob made landfall at Newport, Rhode Island at 2:00 p.m. on August 19, 1991 with the maximum surges from the storm impacting the coastal communities along Buzzard's Bay. The damages and loss of life in New England from Hurricane Bob could have been much greater if Hurricane Bob's landfall had occurred during a period of high tide. Additionally, if the system had not weakened over the cooler New England waters and the radius of maximum winds had not expanded, the surge in Buzzard's Bay could have been greater than surges generated from any of the past New England hurricanes. SLOSH model results for similar intensity storms, discounting the weakening that occurred just prior to landfall, showed that Buzzard's Bay could have experienced surge tides ranging as high as 15 to 25 feet NGVD.

The hurricane preparedness decisions made and actions taken by State and local officials of southeastern Connecticut, Rhode Island, and southern Massachusetts proved to be adequate for Hurricane Bob. The existing communication flow between the NWS, the States, and communities, combined with the existing hurricane preparedness plans appear to have worked well to the degree that local officials, in general, had enough time to make public evacuation decisions and conduct evacuations. The important question is whether these procedures would have been adequate if the meteorological conditions had been different and surge tides of 15 to 25 feet NGVD were experienced. Perhaps those communities that did not activate their EOCs sooner, or those communities that did not arrive at a public evacuation decision prior to deteriorating weather, would not have been able to safely evacuate the public at risk.

One of the concerns identified in this report is the limited use of the NWS hurricane forecast information at the local level. The local officials who are responsible for activating community EOCs need the information provided by the NWS's Marine and Public Advisories for making decisions. As noted previously, during Hurricane Bob many local officials expected landfall to occur in the evening of August 19 or in the morning of August 20. Consistent with the NWS's latest forecasts, landfall occurred at 2 p.m. on August 19. If local officials had received all regularly scheduled Marine and Public Advisories, they would have known, at all times during the event, precisely what Hurricane Bob's position was and when their communities could have expected heightened hurricane conditions.

The information contained in Marine and Public Advisories is not only invaluable for making decisions regarding EOC activation but is also vital for eliminating inaccurate forecasts and misinformation that may circulate among local officials and the public. Local officials, when recommending to the public that they should evacuate, would be able to inform the public of their hazard exposure based on the best forecasts available. Moreover, the highest elected official would have the most accurate information for making evacuation decisions.

In an effort to ensure that State and local officials in southern New England are better prepared to make public evacuation decisions and that these decisions are based on the best possible information, the following recommendations are made:

1. Connecticut and Massachusetts Emergency Management Agencies should augment their NWS subscriptions to include the NHC's Marine Advisories. Marine Advisories contain invaluable forecasts including long range forecasts and detailed meteorological information which are not contained in Public Advisories.
2. Connecticut and Massachusetts Emergency Management Agencies have each taken measures to install an automated link between NWS and their respective State Police criminal justice computer systems. After these links have been established these agencies should revise their State Warning Plans to include procedures for disseminating Marine and Public Advisories to communities linked to the system.
3. Local emergency managers who are unfamiliar with the content of regularly scheduled Marine and Public Advisories, or who are uncertain of the frequency at which these products are disseminated, should consult their State emergency management agency or their local NWS office for more information regarding these products.
4. In communities where the State Police criminal justice computer terminal is not located in the community EOC, emergency managers should conduct prior planning and coordination with their local police authorities for the receipt of weather advisories and State evacuation recommendations sent over the system.

5. State and local emergency management officials should develop standard operating procedures which specifically address at what point, prior to a hurricane, State and community EOCs are activated.

6. Draft hurricane evacuation study products, developed for interim use while final study products are being completed, should be distributed with appropriate support documentation. A suitable number of interim maps should be provided to the emergency management director of each community.

7. Final hurricane evacuation study products need to be fully coordinated and need to consider the comments received from State and local officials. The degree to which final products are used in the future is dependent upon official's understanding the intent of the products and their acceptance of hurricane evacuation study results.

8. Educate emergency management officials and the general public in the forecasting products and information available from the NWS and its limitations. Forecasts are not exact, but they do improve with subsequent updates.

9. Provide public awareness and public education regarding the dangers associated with hurricanes and the need for the public to evacuate when told to do so by local officials.

PART 2: NEW YORK STUDY AREA

I - INTRODUCTION

Study Area Objectives

The objectives of the New York study area assessment were to determine the existing preparedness procedures used by State and local officials and the basis for local officials' decisions to evacuate. Recommendations made as a result of this study will be used to improve the ongoing New York hurricane evacuation study.

Study Area Description

The New York study area consists of the coastal communities in downstate New York, in the counties of New York City, Nassau, Suffolk and Westchester counties.

Data Collection

Hurricane preparedness and response information was collected through a written survey from New York City Emergency Management Office, Nassau and Suffolk Counties Emergency Management, and various coastal communities along the barrier beaches of Long Island, New York. Actions and forecasts by the NWS were also obtained through a written survey.

Theoretical maximum surge information was provided by the National Hurricane Center. Actual stillwater information was obtained from NOAA.

General Impacts of Hurricane Bob for Coastal New York

In the early afternoon of August 19, 1991, the eye of Hurricane Bob passed within 25 miles of Montauk Point, on easternmost Long Island. With winds in excess of 100 miles per hour, and accompanying heavy rains, this hurricane caused power outages to an estimated 380,000 customers. The eastern portion of Suffolk County was most severely impacted by the gale force winds, rain and coastal storm surges produced by Hurricane Bob. Isolated sheltering and feeding operations were implemented for residents affected by the storm. Internal auxiliary power was needed for some 10 hospitals and nursing homes. Fortunately, only 120 residents of Dune Road in the Hamptons required evacuation from their residences as protection from the storm surge and resultant beach erosion.

Prior to the storm, on the morning of August 19, Governor Cuomo declared a State Disaster Emergency under Article 2B of the State Executive Law, to facilitate the State's response actions in support of local governments. In accordance with Article 2B, the Suffolk County Executive declared a local state of emergency.

The State Emergency Management Office (SEMO) contacted FEMA to alert them to the situation in New York and to the potential need for Federal disaster and technical assistance.

II - VULNERABILITY COMPARISON

Only two NOAA recording gages were operating in the area at the time Hurricane Bob passed Long Island: the Battery, New York and Sandy Hook, New Jersey gages. The gage at Montauk, NY was not in operation at the time of the storm. The highest recorded storm surge occurred at the Battery at 5:18 p.m. on August 19. The total water elevation was 9.14 ft. NGVD, with a storm surge of 4.95 ft. At Sandy Hook, the largest storm surge was 4.04 ft., at 5:06 p.m. on August 19, at an elevation of 8.64 ft. NGVD.

The theoretical maximum surges for coastal New York from the SLOSH model, for a Category 2 hurricane, vary from 4.8 ft. NGVD at Patchogue, to 17.5 ft. NGVD at Wards Point. The SLOSH model results were not verified for Hurricane Bob in the New York area, because of its path and due to the lack of recorded storm surge data for New York.

III - COMMUNICATIONS & RESPONSE

This section will describe how the communities in the study area received information on the events of Hurricane Bob, and how the officials came to the decision to evacuate.

The NHC first issued a hurricane watch for the New York area at 12:00 a.m. on August 19, and first issued a hurricane warning at 6:08 p.m. on August 19. The hurricane watch and the hurricane warning were directly communicated from the New York MIC to public officials by telephone and NAWAS, and indirectly through the NWWS and the radio/television media. Hurricane meteorological information was transmitted over the NWWS every two hours. This information included the hurricane intensity, forward speed and position. Evacuation recommendations were not suggested to either the State or local officials by the MIC. Direct communications were established between SEMO and the MIC prior to the landfall of Bob. Additional meteorological reports were transmitted over the phone from the MIC to the Suffolk County EOC, toward landfall. All regular lines of communications were used prior to landfall to inform State and local officials of hurricane updates. The MIC also made a point of calling emergency management officials frequently with updates.

The EOC were fully activated in Nassau and Suffolk counties, New York City and some of the coastal townships by 12:01 a.m., August 19, 1991. Hurricane information came from a wide range of sources, including the NWS, SEMO, radio/television,

New York State Police Information Network (NYSPIN), private weather services, NAWAS, and the Long Island Lighting Company. Some townships reported that they received conflicting meteorological information. The reports from the MIC at the NWS went to Nassau and Suffolk counties and to New York City emergency managers, not directly to the local emergency managers.

Evacuations were recommended by local officials for inundation areas shown on the Hurricane Evacuation Study maps for the Town of East Hampton. Brookhaven recommended the evacuation of Fire Island and low lying mainland areas. The Fire Island National Seashore was evacuated in accordance with the Seashore's evacuation plan, by the morning of August 19. The National Seashore Superintendent in Patchogue made the final evacuation decision. The final decision to evacuate the Fire Island Coast Guard Station was made by the commanding officer at the station. The final public officials' decision of evacuations were made on the morning of 19 August, by each emergency management director, based on weather conditions, community official's prior storm experience and adjacent communities' decisions. Only East Hampton recommended that businesses close.

The Town of Brookhaven noted a conflict. The Suffolk County Emergency Management Office did not advise or confer with the Town that a State of Emergency was going to be declared until after the Declaration was made. The town residents were unsure of the recommended course of action regarding evacuation.

IV - EVACUATION & PUBLIC SHELTERS

Fourteen shelters were opened in the Town of East Hampton from 6:00 to 9:00 a.m. on August 19. None of these were shelters designated by the American Red Cross. 10,500 residents of East Hampton evacuated, by door to door notification. Two shelters were opened in Brookhaven at 10:00 a.m. on August 18, and 100 residents evacuated. The Brookhaven residents were notified by loudspeaker, or local radio and television. For both towns, the public officials highly recommended evacuation to public shelters. The time to complete the evacuations in East Hampton was six to eight hours, and in Brookhaven, eight to 10 hours.

After the storm passed, the American Red Cross opened six shelters, feeding 800 people for the duration of the emergency.

V - INTERIM CORPS/FEMA PREPAREDNESS PRODUCTS

All communities had a response plan prior to Hurricane Bob. The majority of the communities used the New York State Hurricane Evacuation Study inundation maps to assess the flood hazard and determine the areas to be evacuated. Nassau-

County also used the maps to determine possible shelter locations. East Hampton, Nassau County and New York City used the evacuation maps to determine evacuation routes. The majority of the communities felt that the inundation and evacuation maps were suitable for use by local officials in this situation. The general consensus is that the evacuation maps show the worst case scenario. The local and county officials are looking forward to the completion of the New York State Hurricane Evacuation Study, which will include the final evacuation and shelter maps.

VI - CONCLUSIONS & RECOMMENDATIONS

The following comments were provided along with the responses to the survey questionnaire.

1. The New York State Police Information Network (NYSPIN) is very important to local townships if a NWWS terminal is not available. If responsible for evacuations, townships must have a NYSPIN system capable of picking up weather messages.
2. Forecast track of Bob was very good from the NHC. The New York area was very fortunate that there was not a critical wobble in the track a few hours before landfall or the south shore of Long Island would have been heavily damaged.
3. Evacuations during the tourist season may exceed the available shelter capacity.
4. All survey respondents expressed the need for improved communications between the State, county, local officials and the public before, during and after the emergency and for increased familiarity with the hurricane evacuation decision making process.
5. The New York State Hurricane Evacuation Study Technical Data Report will be completed in early 1993.

APPENDIX A

SAMPLES OF INTERVIEW QUESTIONNAIRES

QUESTIONS FOR LOCAL OFFICIALS
ASSESSMENT OF HURRICANE BOB
U.S. ARMY CORPS OF ENGINEERS/FEMA

Name: _____
Title: _____
Phone: _____
Town: _____
Date: _____

1. Comment on your communities evacuation decision making process, and the basis and execution of the process.

2. When was your community's Emergency Operations Center (EOC) activated?

- a. Partially activated TIME: ____:____ AM ____ PM DATE: ____
b. Fully activated TIME: ____:____ AM ____ PM DATE: ____
c. EOC not activated

3. What is the status of the official responsible for operating the EOC?

- a. Full-time emergency manager
b. Part-time emergency manager
c. Full-time official with emergency management responsibilities
d. Part-time official with emergency management responsibilities
e. Volunteer official
f. Other _____

4. List all of the different sources that provided hurricane reports/recommendations for your community or region. (Sources include; National Weather Services, National Hurricane Center, State Office of Emergency Management, radio/TV weather reports, etc.)

5. To what degree were conflicting reports/recommendations received from the different sources identified in question 4?

- a. No conflicts (skip to question 6)
- b. Limited number of conflicts
- c. Moderate number of conflicts
- d. Many conflicts

5a. Briefly explain any major conflicting reports/recommendations received, and the names of the sources providing these conflicting reports/ recommendations.

6. Were reports/recommendations received directly from the State or Area Office of Emergency Management? (reports/recommendations may have originated from other sources)

- a. Yes - Reports, Recommendations, or Both (circle one)
- b. No (If no, skip to question 7)

6a. Were the State/Area's reports/recommendations specific for your community, or were they for a regional area?

- a. Community reports/recommendations
- b. Regional area reports/recommendations

6b. Within 24 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from the State or Area Office of Emergency Management?

- a. No interval - Only one report/recommendation
- b. Random - No consistent time interval
- c. Less than 2 hour intervals
- d. 2-4 hour intervals
- e. 4-6 hour intervals
- f. More than 6 hour intervals
- g. Other _____

6c. What was the final recommendation that was received from the State or Area Office of Emergency Management?

- a. Evacuation of all coastal flood prone areas
- b. Evacuation of all coastal & riverine flood prone areas
- c. Evacuation of select coastal flood prone areas
- d. Evacuation of select coastal & riverine flood prone areas
- e. No evacuation
- f. No final recommendation (skip to question 6e)
- g. Other _____

6d. When was the final recommendation received from the State or Area Office of Emergency Management?

TIME: ____:____ AM ____ PM ____ DATE: _____

6e. What communication method did the State or Area Office of Emergency Management predominantly use to transmit reports/recommendations?

- a. Telephone
- b. Two-way radio
- c. Dedicated Weather Monitoring System (Name: _____)
- d. In person
- e. Radio/Television media
- f. Other _____

7. Were reports/recommendations received directly from a National Weather Service official?

- a. Yes - Reports, Recommendations, or Both (circle one)
- b. No (If no, skip to question 8)

7a. Were the NWS official's reports/recommendations specific for your community, or were they for a regional area?

- a. Community reports/recommendations
- b. Regional area reports/recommendations

7b. Within 24 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from the NWS official?

- a. No interval - Only one report/recommendation
- b. Random - No consistent time interval
- c. Less than 2 hour intervals
- d. 2-4 hour intervals
- e. 4-6 hour intervals
- f. More than 6 hour intervals
- g. Other _____

7c. What was the final recommendation that was received from the NWS official?

- a. Evacuation of all coastal flood prone areas
- b. Evacuation of all coastal & riverine flood prone areas
- c. Evacuation of select coastal flood prone areas
- d. Evacuation of select coastal & riverine flood prone areas
- e. No evacuation
- f. No final recommendation (skip to question 7e)
- g. Other _____

7d. When was the final recommendation received from the NWS official?

TIME: ____:____ AM ____ PM ____ DATE: _____

7e. What communication method did NWS officials predominantly use to transmit reports/recommendations?

- a. Telephone
- b. Two-way radio
- c. Dedicated Weather Monitoring System (Name: _____)
- d. In person
- e. Radio/Television media
- f. Other _____

8. What other major information source, besides the State/Area Office of Emergency Management and NWS officials, provided hurricane reports/recommendations?

- a. No other major information source (skip to question 9)
- b. Source Name: _____
(answers questions 8a through 8e for source identified)

8a. Were the source's reports/recommendations for your specific community, or were the reports/recommendations for a regional area?

- a. Community reports/recommendations
- b. Regional area reports/recommendations

8b. Within 24 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from this source?

- a. No interval - Only one report/recommendation
- b. Random - No consistent time interval
- c. Less than 2 hour intervals
- d. 2-4 hour intervals
- e. 4-6 hour intervals
- f. More than 6 hour intervals
- g. Other _____

8c. What was the final recommendation received from this source?

- a. Evacuation of all coastal flood prone areas
- b. Evacuation of all coastal & riverine flood prone areas
- c. Evacuation of select coastal flood prone areas
- d. Evacuation of select coastal & riverine flood prone areas
- e. No evacuation
- f. No final recommendation (skip to question 8e)
- g. Other _____

8d. When was the final recommendation received from this source?

TIME: ____:____ AM ____ PM ____ DATE: _____

8e. What communication method did this source predominantly use to transmit reports/recommendations?

- a. Telephone
- b. Two-way radio
- c. Dedicated Weather Monitoring System (Name: _____)
- d. Radio/Television media
- e. Other _____

9. What areas did community officials recommend for evacuation to the public?
(More than 1 response possible)

- a. No evacuation recommended (skip to question 18)
- b. Evacuate Corps' inundation areas
- c. Evacuate Corps' evacuation zones
- d. Evacuate FEMA's 100-year flood areas
- e. Evacuate FEMA's 500-year flood areas
- f. Evacuate historical flood prone areas
- g. Other _____

10. Estimate how many residents were evacuated from their homes by community officials.

11. What method was most used to notify residents to evacuate?

- a. Loud speaker announcement while driving
- b. Door to door notification
- c. Local radio station
- d. Local television station
- e. Telephone
- f. Other _____

12. At what level did public officials encourage the use of public shelters to evacuees?
- a. Highly recommended (skip to question 14)
 - b. Moderately recommended
 - c. Slightly recommended
 - d. Not recommended
13. Why was shelter usage not highly encouraged by public officials?
- a. Inadequate means of communicating to public
 - b. Public shelters were not available
 - c. Personnel not available to operate public shelters
 - d. Evacuation occurred early enough for the public to find safe locations
 - e. Other _____
14. What means were most used to inform evacuees of the availability of public shelters?
- a. Loud speaker announcement while driving
 - b. Door to door notification
 - c. Local radio station
 - d. Local television station
 - e. Telephone
 - f. Other _____
15. How many hours did it take to complete your evacuation?
(From decision time to complete excavation)
- a. Less than 4 hours
 - b. 4-8 hours
 - c. 8-12 hours
 - d. 12-16 hours
 - e. More than 16 hours
16. Approximately how many hours of your evacuation completion time were due to traffic congestion?
- a. None
 - b. Less than 1/2 hour
 - c. 1/2-1 hour
 - d. 1-2 hours
 - e. 2-4 hours
 - f. 4-6 hours
 - g. More than 6 hours

16a. Provide a brief description of the areas or roadways that were congested with traffic and significantly delayed your community's evacuation: _____

17. Provide specific public shelter information.

| Shelter Name | Local Designated (Y/N) | ARC Designated (Y/N) | Date Opened | Time Opened | Total Capacity | Total Sheltered |
|-----------------|------------------------------|----------------------------|----------------|----------------|-------------------|--------------------|
|-----------------|------------------------------|----------------------------|----------------|----------------|-------------------|--------------------|

18. When did public officials make, or decide not to make, a final response recommendation to the public?

TIME: ____:____ AM __ PM __ DATE: _____

19. Who made the final emergency response decision?

- a. Town/City Executive Officer
- b. Community Emergency Management Director
- c. Police Chief
- d. Fire Chief
- e. Public Works Official
- f. Town/City Engineer
- g. Other _____

20. What were final emergency response decision predominantly based on?
(prioritize choices if more than one answer)
- a. State Office of Emergency Management recommendation
 - b. Area Office of Emergency Management recommendation
 - c. Local NWS Official
 - d. NHC hurricane reports
 - e. News/weather reports/recommendations
 - f. State Department of Public Safety
 - g. Community officials historical experience
 - h. Adjacent community officials' decision
 - i. Other _____
21. What recommendation was made to businesses by community officials?
- a. No recommendation (skip question 23)
 - b. Recommend closing select businesses
 - c. Recommend closing all, or the majority of businesses
 - d. Other _____
22. What communication method was most used to recommend closure of businesses?
- a. Telephone
 - b. Door to door notification
 - c. Radio
 - d. Television
 - e. Loud speaker notification
 - f. Other _____
23. Did your community have hurricane response plans prior to the landfall of hurricane Bob?
- a. Yes
 - b. Yes, but not current or complete
 - c. No

Inundation Map

24. Did public officials use the draft surge inundation map, provided by the Corps of Engineers and FEMA, for response planning prior to the landfall of hurricane Bob?

- a. Yes
- b. No (skip to question 25)

24a. How was the draft inundation map used? (circle more than one if necessary)

- a. To assess potential flood hazard
- b. To delineate areas for evacuation
- c. To determine feasible evacuation routes
- d. Other uses (1) _____
- (2) _____
- (3) _____

24b. Was the draft inundation map suitable for local officials' purposes?

- a. Yes
- b. No

25. If the draft inundation map was not used, what were the reasons for not using it? (circle more than one if necessary)

- a. Inundation map not available
- b. Overestimates potential flood hazard
- c. Uncertain of the map's purpose
- d. Other reasons (1) _____
- (2) _____
- (3) _____

26. Do you think the draft inundation map accurately depicts areas vulnerable to worst case inundation caused by hurricanes?

- a. Yes
- b. No

Evacuation Map

27. Did public officials use the draft evacuation map, provided by the Corps of Engineers and FEMA, for response planning prior to the landfall of hurricane Bob?
- a. Yes
 - b. No (skip to question 28)
- 27a. How was the draft evacuation map used? (circle more than one if necessary)
- a. To assess potential flood hazard
 - b. To delineate areas for evacuation
 - c. To determine feasible evacuation routes
 - d. Other uses (1) _____
 - (2) _____
 - (3) _____
- 27b. Was the draft evacuation map suitable for local officials' purposes?
- a. Yes
 - b. No
28. If the draft evacuation map was not used, what were the reasons for not using it? (circle more than one if necessary)
- a. Inundation map not available
 - b. Overestimates potential flood hazard
 - c. Uncertain of the map's purpose
 - d. Other reasons (1) _____
 - (2) _____
 - (3) _____
29. Do you think the draft evacuation map is an effective tool for emergency managers to quickly identify areas potentially vulnerable to worst case inundation causes by hurricanes?
- a. Yes
 - b. No

Evacuation and Shelter Data

30. Did public officials use the preliminary evacuation and shelter data, provided by the Corps of Engineers and FEMA, for response planning prior to the landfall of hurricane Bob?
- a. Yes (If yes, skip to question 32)
 - b. No
31. If the preliminary data was not used, what were the reasons for not using it? (circle more than one if necessary)
- a. Underestimates the evacuating population
 - b. Overestimates the evacuating population
 - c. Underestimates the public shelter requirements
 - d. Overestimates the public shelter requirements
 - e. Other (1) _____
 - (2) _____
 - (3) _____
32. Do you think the preliminary evacuation data accurately reflects the number of people that will evacuate assuming that, in worst case hurricane scenarios, entire evacuation zones are recommended for evacuation?
- a. Yes
 - b. No
33. Do you think the preliminary shelter data accurately reflects the number of people that will seek public shelters assuming that, in worst case hurricane scenarios, entire evacuation zones are recommended for evacuation, and shelter usage is promoted?
- a. Yes
 - b. No

34. Additional hurricane preparedness products that should be available in the final hurricane evacuation studies and that which would be useful for hurricane preparedness planning?

- 34a. Comments on the inundation map, evacuation map, and preliminary data.

35. General comments.

QUESTIONS FOR STATE OFFICIALS
ASSESSMENT OF HURRICANE BOB
U.S. ARMY CORPS OF ENGINEERS/FEMA

Name: _____
Title: _____
Phone: _____
Town: _____
Date: _____

1. Provide a brief overview of your hurricane response system including:

1a. Communication structure used:

1b. Response decision making process:

1c. Key entities involved and hierarchy of decision process:

2. When was the State/Area's Emergency Operations Center (EOC) activated?

- a. Partially activated TIME: ____:____ AM ____ PM ____ DATE: ____
- b. Fully activated TIME: ____:____ AM ____ PM ____ DATE: ____
- c. EOC not activated

3. List all of the different sources that provided hurricane reports/recommendations for your communities/areas within your region of responsibility. (Sources include; National Weather Services, National Hurricane Center, radio/TV weather reports, etc.)

4. To what degree were conflicting reports/recommendations received from the different sources identified in question 3?

- a. No conflicts (skip to question 5)
- b. Limited number of conflicts
- c. Moderate number of conflicts
- d. Many conflicts

4a. Briefly explain any major conflicting reports/recommendations received, and the names of the sources providing these conflicting reports/recommendations.

5. Were reports/recommendations received directly from a National Weather Service official?

- a. Yes - Reports, Recommendations, or Both (circle one)
- b. No (If no, skip to question 6)

- 5a. Were the NWS official's reports/recommendations made for specific communities, or were reports/recommendations for regional areas?
- a. Specific community reports/recommendations
 - b. Regional area reports/recommendations
- 5b. Within 48 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from the NWS official?
- a. No interval - Only one report/recommendation
 - b. Random - No consistent time interval
 - c. Less than 2 hour intervals
 - d. 2-4 hour intervals
 - e. 4-6 hour intervals
 - f. 6-12 hour intervals
 - g. More than 12 hour intervals
 - h. Other _____
- 5c. What was the final recommendation (evacuate or not evacuate) that was received from the NWS official?
- a. Evacuation of all coastal flood prone areas
 - b. Evacuation of all coastal & riverine flood prone areas
 - c. Evacuation of select coastal flood prone areas
 - d. Evacuation of select coastal & riverine flood prone areas
 - e. No evacuation recommended
 - f. No final recommendation (skip to question 5e)
 - g. Other _____
- 5d. When was the final recommendation received from the NWS official?
- TIME: ____:____ AM ____ PM ____ DATE: _____
- 5e. What communication method did the NWS officials predominantly use to transmit reports/recommendations?
- a. Telephone
 - b. Two-way radio
 - c. Dedicated weather monitoring system (Name: _____)
 - d. In person
 - e. Radio/Television media
 - f. Other _____
6. Were either meteorological reports or evacuation recommendations received directly from the National Hurricane Center (NHC)?
- a. Yes - Reports, Recommendations, or Both (circle one)
 - b. No (if no, skip to question 7)

- 6a. Were the reports/recommendations specific enough for your hurricane preparedness planning?
- a. Yes
 - b. No
- 6b. Within 48 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from the NHC?
- a. No interval - Only one report/recommendation
 - b. Random - No consistent time interval
 - c. Less than 2 hour intervals
 - d. 2-4 hour intervals
 - e. 4-6 hour intervals
 - f. 6-12 hour intervals
 - g. More than 12 hour intervals
 - h. Other _____
- 6c. What was the final recommendation (evacuate or not evacuate) that was received from the NHC?
- a. Evacuation of all coastal flood prone areas
 - b. Evacuation of all coastal & riverine flood prone areas
 - c. Evacuation of select coastal flood prone areas
 - d. Evacuation of select coastal & riverine flood prone areas.
 - e. No evacuation recommended
 - f. No final recommendation (skip to question 6e)
 - g. Other _____
- 6d. When was the final recommendation received from the NHC?
- TIME: ____:____ AM ____ PM ____ DATE: _____
- 6e. What communication method did the NHC predominantly use to transmit reports/recommendations?
- a. Telephone
 - b. Dedicated weather monitoring system (Name: _____)
 - c. Radio/Television media
 - d. Other _____
7. What other major information source, besides NWS official and the NHC, provided hurricane reports/recommendations?
- a. No other major information source (skip to question 8)
 - b. Source Name: _____
(answers questions 7a through 7e for source identified)

- 7a. Were the source's reports/recommendations specific enough for your hurricane preparedness plan?
- a. Yes
 - b. No
- 7b. Within 48 hours of hurricane arrival, what were the approximate time intervals that reports/recommendations were received from this source?
- a. No interval - Only one report/recommendation
 - b. Random - No consistent time interval
 - c. Less than 2 hour intervals
 - d. 2-4 hour intervals
 - e. 4-6 hour intervals
 - f. 6-12 hour intervals
 - g. More than 12 hour intervals
 - h. Other _____
- 7c. What was the final recommendation (evacuate or not evacuate) that was received from this source?
- a. Evacuation of all coastal flood prone areas
 - b. Evacuation of all coastal & riverine flood prone areas
 - c. Evacuation of select coastal flood prone areas
 - d. Evacuation of select coastal & riverine flood prone areas
 - e. No evacuation recommended
 - f. No final recommendation (skip to question 7e)
 - g. Other _____
- 7d. When was the final recommendation received from this source?
- TIME: ____:____ AM ____ PM ____ DATE: _____
- 7e. What communication method did this source predominantly use to transmit reports/recommendations?
- a. Telephone
 - b. Two-way radio
 - c. Dedicated weather monitoring system (Name: _____)
 - d. Radio/Television media
 - e. Other _____
8. What action did the Governor take prior to the landfall of Hurricane Bob?
- a. No action (skip to question 9)
 - b. Declared a state of emergency
 - c. Other _____

8a. When did the Governor declare a state of emergency?

TIME: ____:____ AM ____ PM ____ DATE: _____

9. For each community in the study area, provide the following information. The community name, the final response recommendation suggested to each community, the time that the final recommendations were suggested to each community, identify whether recommendations were made using direct communication with community officials, provide information regarding the communication method used to transmit recommendations listed. Some recommendation and communication options are provided.

RESPONSE OPTIONS:

- a. No recommendation suggested
- b. No evacuation
- c. Evacuate Corps' inundation areas
- d. Evacuate Corps' evacuation zones
- e. Evacuate FEMA's 100-year flood areas
- f. Evacuate FEMA's 500-year flood areas
- g. Evacuate Historical flood prone areas
- h. Other (explain)

COMMUNICATION METHOD OPTIONS:

- a. Telephone
- b. Two-way radio
- c. Dedicated weather monitoring system
- d. Radio/Television media
- e. Person to person
- f. Other (explain)

| COMMUNITY NAME | RESPONSE OPTIONS (SEE ABOVE) | TIME FINAL RECOMMEND. GIVEN | DIRECT COMMUNICATION (YES OR NO) | COMMUNICATION METHOD OPTIONS (SEE ABOVE) |
|-------------------|------------------------------------|-----------------------------------|--|--|
|-------------------|------------------------------------|-----------------------------------|--|--|

| | | | | |
|-------|-------|-------|-------|-------|
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |

10. What recommendations were given to businesses by State/Area officials?

- a. No recommendation (skip question 12)
- b. Recommend closing select businesses
- c. Recommend closing all, or the majority of businesses
- d. Other _____

11. What communication method was most used to recommend closure of businesses?

- a. Telephone
- b. Radio
- c. Television
- d. Relayed through other Governmental agency
- e. Other _____

Inundation Maps

12. Did State/Area officials use the draft surge inundation maps, provided by the Corps of Engineers and FEMA, for response planning prior to the landfall of hurricane Bob?
- a. Yes
 - b. No (skip to question 17)
- 16a. How were the draft inundation maps used? (circle more than one if necessary)
- a. To assess potential flood hazard
 - b. To delineate areas for evacuation
 - c. To determine feasible evacuation routes
 - d. Other (1) _____
 - (2) _____
 - (3) _____
- 16b. Were the draft inundation maps suitable for State/Area officials' purposes?
- a. Yes
 - b. No
17. If the draft inundation maps were not used, what were the reasons for not using them? (circle more than one if necessary)
- a. Inundation map not available
 - b. Overestimates potential flood hazard
 - c. Uncertain of the map's purpose
 - d. Other (1) _____
 - (2) _____
 - (3) _____
18. Do you think the draft inundation maps accurately depict areas vulnerable to worst case inundation caused by hurricanes?
- a. Yes
 - b. No

Evacuation Map

19. Did State/Area officials use the draft evacuation maps, provided by the Corps of Engineers and FEMA, for response planning prior to the landfall of hurricane Bob?

- a. Yes
- b. No (skip to question 20)

19a. How were the draft evacuation maps used? (circle more than one if necessary)

- a. To assess potential flood hazard
- b. To delineate areas for evacuation
- c. To determine feasible evacuation routes
- d. Other (1) _____
- (2) _____
- (3) _____

19b. Were the draft evacuation maps suitable for State/Area officials' purposes?

- a. Yes
- b. No

20. If the draft evacuation maps were not used, what are the reasons they were not used? (circle more than one if necessary)

- a. Inundation map not available
- b. Overestimates potential flood hazard
- c. Uncertain of the map's purpose
- d. Other (1) _____
- (2) _____
- (3) _____

21. Do you think the draft evacuation maps are effective tools for local officials to quickly identify areas potentially vulnerable to worst case inundation caused by hurricanes?

- a. Yes
- b. No

22. Comments on inundation maps and evaluation maps:

22a. Additional hurricane preparedness products that should be available in the final hurricane evacuation studies that would be useful for hurricane preparedness planning:

23. General Comments

QUESTIONS FOR NATIONAL WEATHER SERVICE OFFICIALS
ASSESSMENT OF HURRICANE BOB
U.S. ARMY CORPS OF ENGINEERS/FEMA

Name: _____
Title: _____
Phone: _____
District: _____
Date: _____

1. What were the times and dates that the National Hurricane Center issued a hurricane watch and a hurricane warning for your region?

Hurricane Watch

Hurricane Warning

Time: _____
Date: _____

Time: _____
Date: _____

2. What means of communication were used to issue hurricane watches and hurricane warnings to public officials?

- a. EBS
- b. Dedicated Weather Monitoring System (Name: _____)
- c. Radio/Television media
- d. Telephone
- e. Other _____

3. What are the approximate time intervals, within 24 hours of storm arrival, hurricane meteorological information is transmitted over the dedicated weather monitoring system?

- a. Random - no consistent time interval
- b. Time interval _____

4. What are the approximate time intervals, within 24 hours of storm arrival, hurricane meteorological information is transmitted over the EBS?

- a. Random - no consistent time interval
- b. Time interval _____

5. Are hurricane intensity (Saffir/Simpson scale), hurricane forward speed, radius of maximum winds, probable storm tract, and hurricane latitude and longitude provided in the dedicated weather monitoring system reports?

| | | |
|---------------------------------|-----|----|
| Hurricane intensity | Yes | No |
| Forward speed | Yes | No |
| Radius of maximum winds | Yes | No |
| Probable storm tract | Yes | No |
| Hurricane lat. & long. position | Yes | No |

6. Are the hurricane parameters outlined in question 5 transmitted to state and local officials on a regular time interval?

Local

Time Interval

| | | | |
|---------------------------------|-----|----|-------|
| Hurricane intensity | Yes | No | _____ |
| Forward speed | Yes | No | _____ |
| Radius of maximum winds | Yes | No | _____ |
| Probable storm tract | Yes | No | _____ |
| Hurricane lat. & long. position | Yes | No | _____ |

State

Time Interval

| | | | |
|---------------------------------|-----|----|-------|
| Hurricane intensity | Yes | No | _____ |
| Forward speed | Yes | No | _____ |
| Radius of maximum winds | Yes | No | _____ |
| Probable storm tract | Yes | No | _____ |
| Hurricane lat. & long. position | Yes | No | _____ |

7. Briefly explain what means of communication used to transmit hurricane parameters outlined in question 5 to state and local officials.

8. Were evacuation recommendations made to either state or local officials?

- a. Yes
b. No (skip to question 9)

- 8a. Were recommendations specific to communities or regional areas?

- a. Yes
b. No

- 8b. For communities or regional areas that recommendations were suggested; identify the communities or regions, provide the recommendations suggested, the times that recommendations were suggested, and the means of communication used to transmit recommendations.

RECOMMENDATION OPTIONS:

- a. No recommendation suggested
- b. No evacuation
- c. Evacuate Corps' inundation areas
- d. Evacuate Corps' evacuation zones
- e. Evacuate FEMA's 100-year flood areas
- f. Evacuate FEMA's 500-year flood areas
- g. Evacuate Historical flood prone areas
- h. Other (explain)

COMMUNICATION METHOD OPTIONS:

- a. Telephone
- b. Two-way radio
- c. Dedicated Weather Monitoring System (Name)
- d. Radio/Television media
- e. Person to person
- f. Other (explain)

| <u>REGION/ COMMUNITY</u> | <u>RECOMMENDATION OPTIONS</u> (see above options) | <u>TIMES SUGGESTED</u> | <u>COMMUNICATION METHOD OPTIONS</u> (see above options) |
|------------------------------|--|----------------------------|--|
|------------------------------|--|----------------------------|--|

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8c. What were the recommendations outlined in question 8b based on?

9. Were direct communication (telephone, fax, etc.) established between the State or Area Office of Emergency Management and a NWS official prior to the landfall of hurricane Bob?

- a. Yes
- b. No (skip to question 10)

9a. Were additional meteorological reports, other than those released over the dedicated weather monitoring system or EBS, provided to state officials using direct communication?

- a. Yes
- b. No

10. Were direct communications established between the news/weather media and a NWS official prior to the landfall of hurricane Bob?

- a. Yes
- b. No

10a. Were additional meteorological reports, other than those released over the weather wire or EBS, provided to the news/weather media using direct communication?

- a. Yes
- b. No

11. Were direct communications established between local officials and a NWS official prior to the landfall of hurricane Bob?

- a. Yes
- b. No (skip to question 12)

11a. Were additional meteorological reports, other than those released over the dedicated weather monitoring system or EBS, provided to the local officials using direct communication?

- a. Yes
- b. No

11b. List the communities that direct communication was established with.

12. List any parties you know that may use your hurricane meteorological reports to relay/develop hurricane reports/recommendations to the public.

13. Comment on the communication structure that was used prior to the landfall of hurricane Bob to inform state and local officials of hurricane forecasts.

[illegible]

14. Comment on communication techniques, means, and channels available that would allow all local emergency managers to quickly obtain the most current hurricane parameters outlined in question 5. This storm information would be used by local emergency managers for making evacuations recommendations to the public hours before the landfall of a hurricane.

15. General comments.

APPENDIX B

LIST OF OFFICIALS INTERVIEWED

National Weather Service Officials Interviewed:

| <u>Name</u> | <u>Office</u> |
|-----------------|----------------|
| Robert Thompson | WSFO Boston |
| Robert Case | WSFO Boston |
| Paul Sisson | WSO Providence |
| David Foose | WSO Bridgeport |
| Scott Whittier | WSO Hartford |

State of Connecticut Officials Interviewed:

| <u>Name</u> | <u>Office</u> |
|-----------------|----------------------------|
| Paul Gibb | CTEMA, Hartford |
| Gary Summa | CTEMA - Area 2, Meriden |
| Anthony Scalora | CTEMA - Area 4, Colchester |

State of Rhode Island Official Interviewed:

| <u>Name</u> | <u>Office</u> |
|----------------|-------------------|
| William Cambio | RIEMA, Providence |

State of Massachusetts Officials Interviewed:

| <u>Name</u> | <u>Office</u> |
|----------------|-------------------------------------|
| Douglas Forbes | MEMA, Framingham |
| Jerry Meister | MEMA, Framingham |
| Steven Finks | MEMA, Framingham |
| Thomas Rodger | MEMA - Area 4, East Bridgewater |
| James Mitchell | Dukes County Civil Defense Director |

Connecticut Local Officials Interviewed:

| <u>Name</u> | <u>Community</u> |
|------------------|------------------|
| William Holohan | Branford |
| Peter Finch | Clinton |
| Fred Johnson | East Lyme |
| Phil Tuthill | Groton City |
| Carl Sawyer | Groton Town |
| Peter Schaumburg | Guilford |
| Gary Reynolds | Madison |
| James Moore | New Haven |
| Reid Burdick | New London |
| Philip Bliss | Old Lyme |
| Elmer Johnson | Old Saybrook |
| George Brennan | Stonington |
| Douglas Peabody | Waterford |
| Karen Sturgeon | Waterford |
| George Pytlik | Westbrook |

Rhode Island Local Officials Interviewed:

| <u>Name</u> | <u>Community</u> |
|----------------------|------------------|
| Peter DeAngelis, Jr. | Barrington |
| Victor Teixeira | Barrington |
| Harold Tucker | Bristol |
| Bernard Lessard | Charlestown |
| Augustine Commella | Cranston |
| Gilbert Hempel | East Greenwich |
| Raymond Benoit | East Providence |
| John McKinnon | Little Compton |
| Jack Crook | Little Compton |
| Michael Embury | Middletown |
| Otis Wyatt, Jr. | Narragansett |
| Garret Sullivan | Newport |
| John Leydon | North Kingstown |
| William MaGill | Pawtucket |
| Harry Johnson | Portsmouth |
| Ed Xazvier | Providence |
| Stephen Alfred | South Kingstown |
| Chief Lamb | Tiverton |
| Frank Tavares | Warren |
| George Carberry | Warwick |
| Peter Kashuluk | Westerly |

Massachusetts Local Officials Interviewed:

| <u>Name</u> | <u>Community</u> |
|-------------------|------------------|
| Rene St Piere | Acushnet |
| Neil Nightingale | Barnstable |
| Charles Noyes | Bourne |
| Barry Eldridge | Chatham |
| Daniel Bryant | Chilmark |
| Timothy Rich | Chilmark |
| Edward Pimental | Dartmouth |
| Ronald Moratta | Dennis |
| John Rodgers | Fairhaven |
| Charles Szulewski | Fall River |
| Margaret Anderson | Falmouth |
| Walter Delaney | Gay Head |
| Peter Welch | Harwich |
| Charles Bradley | Marion |
| H. Eugene Narr | Mashpee |
| William Simpson | Mattapoisett |
| James Day | Nantucket |
| Mark Mahoney | New Bedford |
| Valorie Colebrook | Oak Bluffs |
| Steven Edwards | Orleans |
| William Mlorano | Rehoboth |
| Paul Ciaburi | Rochester |
| David Viera | Seekonk |
| Joseph Medeiros | Somerset |
| Don Butler | Swansea |
| Henry DeCoteau | Tisbury |
| Brian Churchill | Wareham |
| John Early | West Tisbury |
| Louis Degeofry | West Tisbury |
| Michael McCarthy | Westport |
| Robert Edwards | Yarmouth |

APPENDIX C

SAMPLES OF NATIONAL WEATHER SERVICE PRODUCTS

SAMPLE
MARINE ADVISORY

TTAAOO KNHC 182243
HURRICANE BOB MARINE ADVISORY NUMBER 12
NATIONAL WEATHER SERVICE MIAMI FL
2200Z SUN AUG 18 1991

AT 6 PM EDT...HURRICANE WARNINGS ARE EXTENDED NORTH AND EASTWARD FROM CAPE HENLOPEN DELAWARE THROUGH PLYMOUTH MASSACHUSETTS. THE WARNING AREA INCLUDES LONG ISLAND...LONG ISLAND SOUND...CONNECTICUT EAST OF NEW HAVEN...AND CAPE COD. HURRICANE WARNINGS NOW EXTEND FROM LITTLE RIVER INLET NORTH CAROLINA TO PLYMOUTH MASSACHUSETTS.

TROPICAL STORM WARNINGS ARE EXTENDED TO INCLUDE DELAWARE BAY...AND CONTINUE FOR THE LOWER CHESAPEAKE BAY SOUTH OF THE MOUTH OF PATUXENT RIVER INCLUDING THE GREATER NORFOLK AREA. A HURRICANE WATCH IS ALSO ISSUED NORTHWARD FROM PLYMOUTH MASSACHUSETTS THROUGH EASTPORT MAINE.

HURRICANE CENTER LOCATED NEAR 33.9N 76.0W AT 18/2200Z.
POSITION ACCURATE WITHIN 20 NM BASED ON OBSERVATIONS FROM RECONNAISSANCE AIRCRAFT...RADAR...SATELLITE.

PRESENT MOVEMENT TOWARD THE NORTH OR 10 DEGREES AT 16 KT.

DIAMETER OF EYE 20 NM.
MAX SUSTAINED WINDS 100 KT WITH GUSTS TO 120 KT.
RADIUS IN NM OF 64 KT WINDS 100NE 100SE 25SW 25NW.
RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.
RADIUS IN NM OF 34 KT WINDS 150NE 150SE 75SW 75NW.
RADIUS IN NM OF 12 FT SEAS OR HIGHER 150NE 150SE 75SW 75NW.

REPEAT CENTER LOCATED NEAR 33.9N 76.0W AT 18/2200Z.

FORECAST VALID 19/0600Z 36.5N 74.5W.
MAX SUSTAINED WINDS 100KT WITH GUSTS TO 120 KT.
RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.
RADIUS IN NM OF 34 KT WINDS 150NE 150SE 75SW 75NW.

FORECAST VALID 19/1800Z 41.0N 71.0W.
MAX SUSTAINED WINDS 100 KT WITH GUSTS TO 120 KT.
RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.
RADIUS IN NM OF 34 KT WINDS 150NE 150SE 75SW 75NW.

FORECAST VALID 20/0600Z 46.0N 68.0W.
MAX SUSTAINED WINDS 90 KT WITH GUSTS TO 105 KT.
RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.
RADIUS IN NM OF 34 KT WINDS 150NE 150SE 75SW 75NW.

SAMPLE
MARINE ADVISORY (Continued)

STORM SURGE OF 1 TO 7 FEET ABOVE NORMAL TIDE IS POSSIBLE IN THE WARNED AREA OF NORTH CAROLINA AND 3 TO 5 FEET IN THE REMAINDER OF THE WARNED AREA, IN ADDITION...LARGE WAVES WITH BEACH EROSION WILL BE EXPERIENCED IN THE WARNED AREAS.

RAINFALL TOTALS OF UP TO 5 INCHES ARE POSSIBLE ALONG AND NEAR THE PATH OF THE HURRICANE.

TORNADOES ARE LIKELY OVER PORTIONS OF EASTERN NORTH CAROLINA AND EXTREME EASTERN SOUTH CAROLINA.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 33.9N 76.0W.

EXTENDED OUTLOOK

THE FOLLOWING FORECASTS SHOULD BE USED ONLY FOR GUIDANCE PURPOSES BECAUSE ERRORS MAY EXCEED A FEW HUNDRED MILES.

OUTLOOK VALID 20/1800Z 50.5N 60.0W.

MAX SUSTAINED WINDS 70 KT WITH GUSTS TO 85 KT.

RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.

OUTLOOK VALID 21/1800Z 56.0N 47.0W.

MAX SUSTAINED WINDS 60 KT WITH GUSTS TO 75 KT.

RADIUS IN NM OF 50 KT WINDS 125NE 125SE 50SW 50NW.

NEXT ADVISORY AT 19/0400Z.

SAMPLE
PUBLIC ADVISORY

ZCZC 052

ZCZC MIATCPAT3
TTAAOO KNHC 182159
BULLETIN
HURRICANE BOB ADVISORY NUMBER 12
NATIONAL WEATHER SERVICE MIAMI FL
6 PM EDT SUN AUG 18 1991

...HURRICANE BOB STRENGTHENS AND ACCELERATES NORTHWARD...

AT 6 PM EDT...HURRICANE WARNINGS ARE EXTENDED NORTH AND EASTWARD FROM CAPE HENLOPEN DELAWARE THROUGH PLYMOUTH MASSACHUSETTS. THE WARNING AREA INCLUDES LONG ISLAND...LONG ISLAND SOUND...CONNECTICUT EAST OF NEW HAVEN.. AND CAPE COD. HURRICANE WARNINGS NOW EXTEND FROM LITTLE RIVER INLET NORTH CAROLINA TO PLYMOUTH MASSACHUSETTS.

TROPICAL STORM WARNINGS ARE EXTENDED TO INCLUDE DELAWARE BAY...AND CONTINUE FOR THE LOWER CHESAPEAKE BAY SOUTH OF THE MOUTH OF PATUXENT RIVER INCLUDING THE GREATER NORFOLK AREA. A HURRICANE WATCH IS ALSO ISSUED NORTHWARD FROM PLYMOUTH MASSACHUSETTS THROUGH EASTPORT MAINE.

BECAUSE OF THE INCREASE IN FORWARD SPEED...AND THE DECREASING LIKELIHOOD THAT THE HURRICANE WILL TURN TOWARD THE NORTHEAST...HURRICANE WARNINGS HAVE BEEN EXTENDED NORTHWARD TO NEW ENGLAND. THE CENTER OF THE HURRICANE IS EXPECTED TO PASS OVER OR NEAR THE OUTER BANKS OF NORTH CAROLINA LATE THIS EVENING AND THEN MOVE RAPIDLY NORTHWARD...JUST OFFSHORE AND PARALLELING THE MID ATLANTIC COAST...MONDAY MORNING AND OVER NEW ENGLAND MONDAY EVENING. THIS COULD BRING HURRICANE CONDITIONS TO IMMEDIATE COAST WEST OF THE CENTER AND LATER TO THE NEW ENGLAND AREA.

LATEST AIR FORCE RESERVE UNIT AIRCRAFT REPORTS INDICATE THAT HURRICANE BOB IS NOW A VERY DANGEROUS...CATEGORY 3 HURRICANE ON THE SAFFIR-SIMPSON HURRICANE SCALE...PACKING 115 MPH WINDS. RESIDENTS IN THE WARNED AREAS OF NORTH CAROLINA...PARTICULARLY THOSE ON THE OUTER BANKS...SHOULD HAVE COMPLETED EVACUATIONS AND PREPARATIONS FOR THE HURRICANE. DETAILS OF ACTIONS TO BE TAKEN ARE INCLUDED IN STATEMENTS BEING ISSUED BY LOCAL NATIONAL WEATHER SERVICE OFFICES.

AT 6 PM EDT...2200Z...THE CENTER OF BOB WAS LOCATED NEAR LATITUDE 33.9 NORTH...LONGITUDE 76.0 WEST OR ABOUT 90 MILES SOUTH OF CAPE HATTERAS NORTH CAROLINA.

BOB IS MOVING TOWARD THE NORTH NEAR 18 MPH AND THIS MOTION IS EXPECTED TO CONTINUE WITH AN INCREASE IN FORWARD SPEED TONIGHT.

MAXIMUM SUSTAINED WINDS ARE NEAR 115 MPH AND LITTLE CHANGE IN STRENGTH IS LIKELY DURING THE NEXT 24 HOURS.

SAMPLE
PUBLIC ADVISORY (continued)

HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 115 MILES TO THE EAST AND 30 MILES WEST FROM THE CENTER...AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 175 MILES EAST AND 90 MILES WEST FROM THE CENTER.

THE MINIMUM CENTRAL PRESSURE REPORTED BY RECONNAISSANCE AIRCRAFT WAS 962 MB...28.41 INCHES.

TORNADOES ARE LIKELY OVER PORTIONS OF EASTERN NORTH CAROLINA AND SOUTHEASTERN VIRGINIA TONIGHT AS RAINBANDS MOVE ASHORE.

A STORM SURGE OF 4 TO 7 FEET ABOVE NORMAL TIDE IS LIKELY IN THE WARNED AREA OF NORTH CAROLINA AND 3 TO 5 FEET IN THE REMAINDER OF THE WARNED AREA. IN ADDITION...LARGE WAVES WITH BEACH EROSION WILL BE EXPERIENCED IN THE WARNED AREAS.

SMALL CRAFT IN THE WATCH AREA SHOULD REMAIN IN OR NEAR PORT.

RAINFALL TOTALS OF UP TO 5 INCHES ARE POSSIBLE ALONG THE PATH OF THE HURRICANE. OUTER RAINBANDS ARE PRESENTLY MOVING OVER EXTREME SOUTHEASTERN NORTH CAROLINA AND NORTHWARD INTO VIRGINIA.

REPEATING THE 6 PM EDT POSITION...33.9 N...76.0 W. MOVEMENT...NORTH NEAR 18 MPH. MAXIMUM SUSTAINED WINDS...115 MPH.
MINIMUM CENTRAL PRESSURE...962 MB.

INTERMEDIATE ADVISORIES WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 8 PM EDT AND 10 PM EDT FOLLOWED BY THE NEXT COMPLETE ADVISORY ISSUANCE AT MIDNIGHT EDT...MONDAY.

GERRISH

SAMPLE
PUBLIC ADVISORY (continued)

ADVISORY NUMBER 12 HURRICANE BOB POSSIBILITIES
FOR GUIDANCE IN HURRICANE PROTECTION PLANNING
BY GOVERNMENT AND DISASTER OFFICIALS

CHANCES OF CENTER OF THE HURRICANE PASSING WITHIN 65 MILES OF
LISTED LOCATIONS THROUGH 2 PM EDT WED AUG 21 1991

CHANCES EXPRESSED IN PERCENT...TIMES EDT

| COASTAL LOCATIONS | THRU 2 PM MON | ADDITIONAL PROBABILITIES | | | TOTAL THRU 2 PM WED |
|----------------------|------------------|------------------------------|------------------------------|------------------------------|---------------------------|
| | | 2 PM MON THRU 2 AM TUE | 2 AM TUE THRU 2 PM TUE | 2 PM TUE THRU 2 PM WED | |
| 41.0N 71.0W | 32 | 5 | X | X | 37 |
| 46.0N 66.0W | X | 17 | 4 | X | 21 |
| 50.5N 60.0W | X | 1 | 11 | 2 | 14 |
| WILMINGTON NC | 7 | X | X | X | 7 |
| MOREHEAD CITY NC | 61 | X | X | X | 61 |
| CAPE HATTERAS NC | 77 | X | X | X | 77 |
| NORFOLK VA | 30 | X | X | X | 30 |
| OCEAN CITY MD | 34 | X | X | X | 34 |
| ATLANTIC CITY NJ | 26 | 1 | X | X | 27 |
| NEW YORK CITY NY | 23 | 2 | 1 | X | 26 |
| MONTAUK POINT NY | 30 | 5 | X | X | 35 |
| PROVIDENCE RI | 24 | 9 | X | X | 33 |
| NANTUCKET MA | 26 | 9 | X | X | 35 |
| HYANNIS MA | 23 | 11 | X | X | 34 |
| BOSTON MA | 15 | 14 | X | 1 | 30 |
| PORTLAND ME | 4 | 20 | X | X | 24 |
| BAR HARBOR ME | 2 | 22 | 1 | X | 25 |
| EASTPORT ME | 1 | 21 | 1 | X | 23 |
| ST JOHN NB | X | 19 | 2 | 1 | 22 |
| MONCTON NB | X | 15 | 5 | X | 20 |
| YARMOUTH NS | 1 | 20 | 1 | X | 22 |
| HALIFAX NS | X | 12 | 4 | X | 16 |
| SABLE ISLAND NS | X | 2 | 3 | 1 | 6 |
| SYDNEY NS | X | 4 | 7 | 1 | 12 |
| EDDY POINT NS | X | 6 | 6 | 1 | 13 |
| PTX BASQUES NFLD | X | 3 | 9 | 1 | 13 |
| BURGeo NFLD | X | 1 | 8 | 2 | 11 |
| ILE ST PIERRE | X | 1 | 4 | 2 | 7 |
| CAPE RACE NFLD | X | X | 2 | 2 | 4 |
| HIBERNIA OILFLD | X | X | 1 | 2 | 3 |

X MEANS LESS THAN ONE PERCENT

SAMPLE
HURRICANE LOCAL STATEMENT

NNNN

<

<ZCZC BOSHLSBOS
TTAAOO KBOS 191246
MAZALL-191700-
BULLETIN
IMMEDIATE BROADCAST REQUESTED
HURRICANE BOB LOCAL STATEMENT...UPDATED
NATIONAL WEATHER SERVICE BOSTON MA
1100 AM EDT MON AUG 19 1991

...ACTING GOVERNOR CELLUCCI HAS DECLARED A STATE OF EMERGENCY FOR THE
STATE OF MASSACHUSETTS...AS DANGEROUS 115 MPH HURRICANE BOB TAKES AIM AT
SOUTHERN NEW ENGLAND...

...DANGEROUS HURRICANE BOB IS BEARING DOWN ON THE SOUTHERN NEW ENGLAND
COAST...

THIS AFFECTS THE FOLLOWING MASSACHUSETTS COUNTIES...ESSEX...SUFFOLK...
NORFOLK...PLYMOUTH...BARNSTABLE...DUKES...NANTUCKET AND BRISTOL.

...A FLOOD WATCH IS IN EFFECT FOR ALL OF MASSACHUSETTS...

...A HIGH WIND WARNING IS IN EFFECT FOR ALL OF MASSACHUSETTS EXCEPT THE
BERKSHIRES...

...A TORNADO WATCH IS IN EFFECT FOR ALL OF MASSACHUSETTS...

...RESIDENTS OF MASSACHUSETTS ARE ADVISED THAT UNLESS YOU ARE REQUESTED TO
EVACUATE AVOID ALL TRAVEL...UNLESS IT IS A CASE OF EMERGENCY...

AT 11 AM EDT...DANGEROUS HURRICANE BOB WAS LOCATED NEAR LATITUDE 40.2...
LONGITUDE 72.2 OR ABOUT 115 MILES SOUTH SOUTHWEST OF PROVIDENCE RHODE
ISLAND. THE HURRICANE CONTINUES TO MOVE TOWARDS THE NORTH NORTHEAST AT
JUST OVER 30 MPH.

STORM FORCE WINDS HAVE REACHED THE NEW ENGLAND COAST.
GROTON...CONNECTICUT REPORTED A GUST OF 57 MPH WITHIN THE PAST HOUR.
HURRICANE FORCE WINDS WILL MOST LIKELY REACH THE SOUTHERN NEW ENGLAND
COAST BY NOON AS THE CENTER OF BOB MOVES ONSHORE ALONG THE RHODE ISLAND
COAST BETWEEN 1 AND 3 PM EDT.

HURRICANE BOB IS A DANGEROUS HURRICANE AND CAN BE COMPARED IN STRENGTH TO
HURRICANE CAROL OF 1954. CAROL KILLED 60 PEOPLE AND INFLICTED 2.3 BILLION
DOLLARS IN DAMAGE IN THE NEW ENGLAND AREA. ALL PREPAREDNESS ACTIONS
SHOULD BE COMPLETED

SAMPLE
HURRICANE LOCAL STATEMENT (Continued)

STORM SURGES OF 4 TO 7 FEET ARE LIKELY ALONG THE SOUTH FACING COAST FROM CHATHAM WEST TO THE POINT OF LANDFALL. HIGHER SURGES ARE LIKELY IN BAYS AND INLETS WITH SURGES AS HIGH AS 15 TO 17 FEET POSSIBLE IN THE UPPER END OF BUZZARDS BAY INCLUDING THE TOWNS OF ONSET...MATTAPOISETT AND POCASET HAVE RECORDED VERY HIGH SURGES OF 15 TO 20 FT IN PAST HURRICANES.

STORM SURGES OF 3 TO 5 FEET ARE LIKELY ALONG THE EAST COAST OF MASSACHUSETTS FROM CHATHAM NORTH TO THE NEW HAMPSHIRE BORDER...INCLUDING THE WEST SIDE OF CAPE COD.

IF YOU ARE IN INLAND AREAS THE MAIN THREAT IS HIGH WIND DAMAGE AND FLOODING ALONG THE RIVERS AND STREAMS THAT MAY NORMALLY BE DRY. THE 5-10 INCHES OF RAIN THAT WILL ACCOMPANY HURRICANE BOB WILL CAUSE FLASH FLOODS. HAVE A PLAN AND BE READY TO SEEK HIGHER GROUND IF PROLONGED RAINS CAUSE FLOODING OR IF A FLASH FLOOD WARNING IS ISSUED.

LISTEN TO LATEST STATEMENTS FROM YOUR LOCAL NATIONAL WEATHER SERVICE OFFICE...NATIONAL HURRICANE CENTER...AND EMERGENCY MANAGEMENT OFFICIALS.

THE NATIONAL WEATHER SERVICE IN BOSTON WILL ISSUE ANOTHER STATEMENT AROUND 1 PM EDT MONDAY

CASE